SIR ARTHUR S. EDDINGTON

In the sciences of Astronomy and Physics Sir Arthur Eddington has a world wide reputation. Born at Kendal he is now fifty-two years of age. He has been Plumian Professor of Astronomy at Cambridge University since 1913. His now famous book *The Nature of the Physical World* was first published in 1928 and it has been discussed more fully perhaps than any other recent scientific book of recent years, one reason for this being that in this book, as he says, he discusses some of the results of modern study of the physical world which give most food for philosophic thought. There we find valuable new conceptions in science and also new knowledge. In both respects we are led to think of the material universe in a way very different from that prevailing at the end of the last century.

OUTLINE OF MODERN BELIEF

MODERN SCIENCE
MODERN THOUGHT
RELIGIOUS THOUGHT

EDITED BY

J. W. N. SULLIVAN

AND

WALTER GRIERSON

(The Enquiring Layman)

VOLUME ONE

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INTRODUCTION

THE term *Modern Belief* as used in the title of this work has a wider meaning than may at first appear. It includes what may be said to be known, as reasonably certain facts, about a number of things, as well as beliefs for which firm knowledge cannot as yet be claimed. So far are the findings of Science, in many directions, from finality and certainty that the title of this work, *Outline of Modern Belief*, is as appropriate for modern science as for the other branches of modern thought that are dealt with.

This work, *Outline of Modern Belief*, is divided into three Books giving a survey of three branches of knowledge on which every intelligent person would wish to be reasonably well informed.

Each of these Books, or sections, is self-contained, and *each* Book will be continued serially in the successive fortnightly parts. In fact, running like three fascinating serial stories.

One of the interesting things about modern science which has come about within the last thirty years, is not only the new discoveries in the realm of astronomy and physics and biology, but the philosophical implications of these discoveries. The centre of real interest, from the philosophic point of view, is the new "background" of modern science. Two of the most eminent scientists in this country have recently given much prominence to this subject. The attempts of Sir Arthur Eddington and Sir James Jeans to construct a philosophy out of modern science have attracted a great deal of attention. Their views about the real nature of the universe, and the bearing which the new ideas have on the life of man and his destiny, have been widely discussed. We shall, therefore, try to explain fully their views, and the views of other men, in this connection, but this will come later in the present work, for as Sir James Jeans writes: "There is a wide spread conviction that the new teachings of astronomy and physical science are destined to produce an immense change on our outlook on the universe as a whole, and on our views as to the significance of human life. The question at issue is ultimately one for philosophic discussion, but before the philosophers have a right to speak, science ought first to be asked to tell all she can as to ascertained facts and provisional hypotheses. Then and then only, may discussion pass into the realms of philosophy."

We shall, therefore, in the earlier chapters of "Modern Thought," try to clearly explain what the findings of modern science are in its various branches. Then in later chapters the reader will be better able to follow those chapters devoted to the philosophic beliefs of men of science, and to see the grounds for their beliefs. The new knowledge has philosophical implications, and although there is room for difference of opinion as to what precisely they are, most scientists, like Eddington and Jeans, think "that few will be found to doubt that some reorientation of scientific thought is called for." And the change of outlook will be away from the materialism and strict determinism of last century "towards something (as Sir James Jeans says) which will accord better with our every day experience."

But, as we have said, before we come to these aspects of modern scientific belief we shall confine the earlier chapters of "Modern Thought" to a description of the conclusions of science in its various branches. After that we shall see something about the new "background" of science, and the reader will be better equipped to appreciate what the nature of the "background" is, and what scientists deduce from it, as now revealed to them by physics and astronomy. The electron theory, the quantum theory, and relativity theory, form the background of modern science; they all deal with conceptions that lie at the back of the concrete objective world of our sense experience; they are concerned with the invisible and intangible aspects of natural science. Eddington writes: "I am convinced that a just appreciation of the physical world as it is understood to day carries with it a feeling of

open mindedness towards a wider significance transcending scientific measurement, which might have seemed illogical a generation ago"

BOOK I

The aim of Book I is to put readers in touch with the trend of present day thought, for example, the beliefs of modern science about the nature of the universe, and of life, and the meaning of things—the things, that is to say, which inquiring minds like to think about The authors set about this, in Book I, by giving a clearly written and plainly worded account of the results, or present conclusions, of modern science in most of its various branches It is written for the general reader who wants to be informed to give him something to think about, in a word, to give him just the kind of information he wants to have

In the light of modern knowledge—we might say of twentieth century knowledge—great changes have come over our views about the nature of the physical universe, just as have our beliefs concerning traditional religion About both these things the majority of people have but hazy and scrappy knowledge The two things have not necessarily any connection, but both come within the scope of a work dealing with modern beliefs The present century has been revolutionary in the realms of science, no less than in our more general ways of thinking, largely affected as they have been by the conclusions of modern science, of new knowledge resulting from fresh discoveries, and free criticism

The present is one of the most exciting of all epochs of human thought Modern science has revealed as never before, the mysterious nature of the universe, and the philosophical implications of the new scientific teaching quicken the imagination and excite the interest of every intelligent person

The object of Book I, then, is to give a clear and concise summary, or bird's eye view, of the net *results* of modern science, and, secondly, of changes in men's ideas which have been effected by new knowledge, discovery, research, and by special study in other fields than science This section will not be burdened by too much detail, so apt to be confusing to the general reader who wants a bird's eye view The results can, in many cases, be presented without giving details, or the reasoning, by which they were achieved That is the aim of Book I

WE are constantly told that during the present century science has completely revolutionised our conception of the universe And that is quite true The scientific world-picture of thirty years ago is now obsolete We have a new picture, and a peculiarly interesting one The old mechanistic conception of the universe, and purely materialistic theories of life, seem to have been finally abandoned *How* and *why* this has come about will become apparent to readers of this part of the present book because it deals more with results than details

These things, then, are the questions dealt with under "Modern Thought" And, of course, a great deal more, for modern thought is concerned with far more than science, and its implications The editors make a feature of explaining the views of individual representative thinkers of to day, not only on the new scientific theories and their philosophical implications, but on their general outlook Their own words are frequently quoted and duly acknowledged in the proper place There is a marked tendency on the part of many leading scientists to make excursions into the realms of philosophic thought, and, in a broad sense, religion The general public find these expressions of belief of keen interest, else there is no accounting for the tremendous success of Sir Arthur Eddington's recent books, and Sir James Jeans's also Some of them have sold to the tune of over 100 000 each And they are pretty stiff reading, too The authors are great men of science, and of course use scientific language Their theories, and beliefs, told in a somewhat plainer way, more suggestive than scientific, as done in the present work, will be welcomed by those who can make no close study of special subjects

The editors of this Outline try to fill the role of middlemen between the specialists on the one hand, and on the other the plain man who wants to get at the gist of the thing What do all these new ideas mean, or in other

words, what bearing have they on our ideas about the nature of the universe, and life?

BOOK II

Book II is a fairly comprehensive outline of general science,* explaining in as clear and non-technical a manner as possible those sciences in which the average person is most interested, for instance, Astronomy and Physics, and particularly the new theories about the atom, the electron theory, and the nature of matter; so also the sciences which deal with Evolution and the whole history of the past in relation to man. The question is "Darwinism" true, has been much to the front in recent years. The conclusions of the best authorities will be explained. Biology, Psychology or Mental Science, Physiology and Natural History, are just as full of living interest for the ordinary man; the more he reads the more he will want to know.

This brief Outline (Book II) we believe will meet a need of the moment, for within the compass of the present century science has made immense strides. To make the acquaintance of modern science—so unlike the dry-as-dust science of old—is a fascinating intellectual pursuit, or hobby if you like to call it, for one's leisure hours It is like reading a romance, so intensely interesting is it, even to the plain man who is not of a scientific turn of mind The old astronomy told us about the sun, the stars, the planets, their place in the heavens, their movements, revolutions, their nature and peculiarities, the new astronomy goes far beyond that when it speaks about the birth and death of suns and stars, how they are born and why they die; about the mystery of the immense nebulæ from which the stars are born, and about whence came the nebulæ.

There are few more exciting things in all science than the description astronomers like Eddington and Jeans give us of what is happening in the interior of the sun and the stars; of what will happen to the sun—which means, too, the end of life on the earth—when at long last the sun has run its course of untold millions of years. The greater part of all this is new knowledge within comparatively recent years.

So also our knowledge of the stellar universes that lie far away at immense distances beyond "our universe," and outside of it. So, too, our knowledge of the mysterious nebulæ. How did they come into being? Astrophysics is a comparatively new science, and to it we owe our knowledge of the nature of these primeval nebulæ If suns and stars are born of the nebulæ, what are nebulæ? Did they originate from the coming together of those immaterial electric entities or energies which science calls electrons and protons, which are as yet so little understood? But as they constitute all matter, the stuff out of which all matter is made, they are regarded as "the germs of the things that are to be," the far-off begetters of the human beings we are, and every other animal, plant, and living thing Such are some of the things about which present-day astronomers speak.

And here the astronomer joins hands with the physicist Just as Darwinism and the Evolution theory changed the whole character of Biology (and other sciences), so did the discovery of radio-activity some thirty years ago, the later discovery of the electron, then the quantum, change the scientists' mode of regarding the universe. And, of course, the revolutionary Relativity Theory belongs to our own day

The recent development of Physics has been called "the most exciting episode in the history of science." The old science of physics dealt with energies—light, heat, electricity, and gravitation, all a little boring to the general reader. We now realise that these old divisions are artificial. The present day physics has enlarged its scope and interest Indeed, as matter and energy now seem to be one and the same thing, the sciences of astronomy, chemistry, and physics all overlap and are not only co-operating in the solving of cosmic problems, but are all really engaged on various aspects of one problem.

* Some of the chapters in Book II are adapted from, or based on, a previous work issued by the same publishers, *The Outline of Science*, edited by the late Sir J Arthur Thomson (who was keenly interested in the preparation of the present work) But the presentation of the facts is mostly on somewhat different lines, to suit the character of the present work Such has been the progress made in many branches of science since the older work was published that it is already in need of amplification

SOME REPRESENTATIVE NAMES IN THE

[Photo Russell

SIR A. S. EDDINGTON

No book in recent times has had such a wide popularity as Eddington's "The Nature of the Physical World." Its aim was to make clear the scientific view of the world as it stands to-day and to describe the philosophical outcome of the recent changes of scientific thought. Eddington is also author of "Stars and Atoms" and of "Science and the Unseen World."

[Photo Press Portrait Bureau

SIR JAMES JEANS

His work and his books have earned him world fame. Like Eddington, he is pre-eminent as astronomer, physicist, and mathematician. He is the author of "The Mysterious Universe," "Stars in their Courses," "The Background of Science" and "The Universe Around Us."

[Photo Swaine

SIR ARTHUR KEITH

He is a leading authority on the Antiquity of Man. His latest book, "New Discoveries Relating to the Antiquity of Man" (1932), is a mine of information. He is the author of a fascinating book on the working of the human body called "The Engines of the Human Body."

[Photo Vaughan and Freeman

PROFESSOR J. B. S. HALDANE

He is an authority on Biology and the science of Heredity. He has published a collection of his interesting popular essays under the title of "Possible Worlds and Other Essays." He is joint author with Professor Julian S. Huxley of one of the best text books on biology, entitled "Animal Biology."

[Photo Lenare

PROFESSOR JULIAN S. HUXLEY

He is a grandson of the famous T. H. Huxley. He is a notable biologist and a keen student of bird life (see his "Essays of a Biologist"). He is also the author of a book, "Religion without Revelation," which is a [illegible] and statement of his religious outlook.

[Photo [illegible] and Fry

SIR OLIVER LODGE

A remarkably well equipped scientist and one of the pioneers of modern physics and wireless telegraphy. Author of "Electrons," "Modern Views of Matter," "The Ether of Space," "Beyond Physics" and "My Philosophy" (1933). A great advocate of Psychical Research.

WORLD OF MODERN SCIENCE AND THOUGHT

[Photo Swaine

SIR J ARTHUR THOMSON
(Died 1933)

He was much interested in the preparation of the present work and was revising some of its chapters before his death

He was an authority on Evolution and Natural History His numerous books are well known, the most important of which is "The System of Animate Nature"

[Photo Elliott and Fry

PROFESSOR C LLOYD MORGAN

A leading authority on Psychology and the theory of Emergent Evolution His views carry great weight Author of "The Interpretation of Nature," and a fine book, "Life, Mind and Spirit," and one on "Instinct and Experience" An authority on Animal Behaviour

[Art Photo Service

BERTRAND RUSSELL

First and foremost a philosopher of very "advanced" views His books are widely read, including "The Analysis of Mind," "The A B C of Relativity," "Problems of Philosophy," "What I Believe," and "Sceptical Essays"

[Photo Lenare

DR W R INGE

A great scholar and one of the leaders of Modernism in religious thought His philosophy will be explained in Book III of the present work

He is the Author, among many other works, of

"Outspoken Essays"

"Things New and Old"

"The Church in the World"

[Photo Elliott and Fry

CANON B H STREETER

A learned modernist and an authority on origins sources, and authorship of the New Testament Writings

Editor of "Foundations Christian Belief in Terms of Modern Thought" And Author of "Adventure The Faith of Science"

[Photo Vaughan and Freeman

C LEONARD WOOLLEY

Modern knowledge has been greatly extended in recent years by the discoveries and the excavation work in Palestine and Egypt of such men as Mr Woolley, Sir Flinders Petrie, Professor Garstang, and many other archæologists These discoveries will be described in the present work

Mr Woolley is Author of "Digging Up the Past," and "Ur of the Chaldees"

They are all engaged, we may say, in the study of Evolution, using this term in an unrestricted sense The term is more strictly reserved for the evolution of living things Another absorbing science, or rather several sciences, deals with the Origin and the Antiquity of Man, a subject on which much new light has been thrown in the last two decades The rapidity of fresh discoveries in the last two decades bearing on the antiquity of man is astonishing As Sir Arthur Keith has said, it is difficult to keep abreast of new discoveries in this field

The same can be said about the science of Biology, or the Science of Life How life came to a lifeless world we do not know, but the new light thrown on the processes of evolution is comparable with the advances in astronomy and physics Did Life come from lifeless matter? Can we draw a definite line between living things and "dead" matter? Did Mind "emerge"? These are some problems which will be considered in their place The biologist is on firmer ground in describing the development of life than he ever was before Our complex bodies spring from germ cells, and it is one of the most interesting discoveries of biology that these germ cells, or we should say, the chromosomes in the cells, are the physical basis and contain the secret of inherited qualities They contain "the stuff of heredity" How do new species arise? Is the Darwinian doctrine of 'natural selection" proven? Is there any substance in Bergson s popular doctrine of Creative Evolution? Is the theory of Emergent Evolution true? Has Mind emerged in the course of evolution? What is the relation between mind and body? Has the mind a material basis, and that basis the brain? When we come to problems like these, "Belief" is founded as much on philosophy as on science There are other aspects of our nature than those dealt with by science

BOOK III

Book III of this work is devoted to Religious Thought No outline of Modern Belief could afford to omit the subject of Religion The evolution of religious ideas has occupied the minds of many scholars, it is a fascinating study of the reaction of the minds of men, in all ages to the world in which they live and the greater universe, seen and unseen, which surrounds them There is perhaps no subject at the present day on which there is more confusion of mind than religion

Many old traditional beliefs have been abandoned, but many quite intelligent people could not explain what the "modernist" views held by leaders of religious thought to day really are During the present century institutional Christianity, and the New Testament records themselves, have been passing through the furnace of historical and "scientific" criticism, from which they have not yet completely emerged But we can say that the word Religion has taken on a wider meaning

The entities with which Science deals form only a partial aspect of reality That cannot be doubted It is quite true that ' feelings, purpose, values, make up our consciousness as much as sense impressions." They are the real things of the mind Most of the leading scientists of to day are a long way from old fashioned materialism, materialism has taken a new turn as we shall see in this book Of fundamental reality that escapes and transcends science, science cannot speak It is religion, in its broad sense, and philosophy that keep "spirit" and "intuition" and the "mystic ' in the picture of reality

Religion—we use the word in its widest significance—has travelled as far from crude beginnings as Science has done from its crude beginnings It has to be admitted, however, that in its outlook and by reason of formulated and static creeds Religion has lagged behind Science in achieving wider vision The religious effect of the idea of evolution has been revolutionary, it has had "a purging and dissolving effect" on theology The relations of science and religion have become altered There have been "passing theories" in theology as there have been in science Both have shed their infant clothes As knowledge has grown, so have men's religious beliefs passed from one phase to another

In the Light of To-day

It is probably true that the bulk of educated men and women of our day are alienated from all organised forms of religion As Dr Maurice Wilson remarks, "The great majority of them are very far from being opposed, or even indifferent, to religion they are not atheistic But they find the popular, traditional, and apparently authorised presentation of Christian theology by the Churches confused and contradictory, or superficial and obscurantist, and as it stands, to them impossible" (*Evolution in the Light of Modern Knowledge*)

Dr Wilson puts the matter in a nutshell when he says

> It has been the universal assumption in the past that there were two separate spheres of existence, and that these were wholly distinct in kind They were regarded respectively as natural and "supernatural" Exceptional occurrences in the natural were to be explained as caused by the irruption of the supernatural into the natural Religion originated and has been largely concerned in dealing with these supposed irruptions Parts of Christian theology have been occupied with them These were "first thoughts" But now the human mind—ought we not to say under the continuous teaching of man by the Spirit of Truth—is rejecting the whole conception of this irruption of one sphere into another It identifies in kind what we have called the supernatural with the natural It makes the spiritual and the natural continuous and equally divine This identification is, as it were, regularised as well as illustrated by the idea of evolution This is the needed continuity, gained not by denying or degrading the supernatural but by raising the natural into entire continuity with it There is continuity To us intelligence, mind, spirit, is now seen as one long continuous chain, of which we see neither beginning nor end We are perhaps at least as far from the top of it as we are from the bottom

It is Mr Middleton Murry who makes a remark which is an obvious truth (and obvious truths are sometimes arresting when plainly stated, just because they are obvious we had not thought of them) "Believers in evolution, and believers in traditional Christianity, have one important belief in common Strangely, neither seem to be aware of it They are both committed to a belief in the possibility of a new kind of man

A Specific Purpose

Book III, then, has a specific purpose, it tells the historical story of the evolution of three religions in particular, and they will be dealt with in some detail as illustrative of the progressive development of religious ideas We shall confine ourselves to the broad question of religion in recorded history, and its development to a place in modern thought, alongside scientific and philosophical thought As knowledge has grown so have men's religious beliefs passed from one phase to another And it is to the modern phase the short history that is given leads up Unless we know the past we shall not understand the present *This is specially true of the Christian religion*

This part of our Outline is concerned with describing the evolution of three religions the ancient Hebrew, the ancient Greek, and the Christian, the last named of which sprang from the other two Or, rather, it would be truer to say that the Christian religion sprang from the Hebrew, and when it came to be formulated as a *theology* it was largely in terms of Greek philosophy As an organised institutional religion, Christianity also appropriated, as we shall see, many of the ceremonial customs and practices of the Greek pagan mystery religions All this is now freely admitted by theological scholars

The Historical Background

The present century has been just as busy in historical research, and discovery, and in Biblical criticism as it has been in the field of science We shall relate some of the principal results of modern discoveries, historical research, and free critical thought, bearing on the Biblical account of Hebrew history, and the sources of the writings, that became the Old Testament We shall also relate the effect of critical thought on the New Testament The Bible itself is one of those things about which the majority of people are not well informed It can hardly be intelligibly understood without some knowledge of the history and the current thought of the period in which it was born This is just as true of the New Testament as it is of the Old Testament *In all these things it is the*

historical background that is important, and that is what is given in some detail

Then, just as we trace the evolution of the Hebrew religion, so shall we describe the like evolution of the religion of the ancient Greeks The development of the pagan religion of the Greeks contemporaneous in time with Hebrew history, bears a striking analogy to the Hebrew, they move on parallel lines, yet are quite distinct and typical in their conceptions The Hebrews created an origin for themselves, so did the Greeks From the Homeric gods and demi gods we pass to the later Greek national gods, and mythology, and from mythology to allegory—to mystical rites and worship, to the Eleusinian and Orphean "mystery religions," the last mentioned a type of religion which had far flung influences, and finally to the emergence of Greek philosophy, to the great names of Socrates, Plato, and Aristotle, whose influence is still alive to-day Finally, after bringing the story of the Hebrew religion, and the religion and philosophy of the ancient Greeks, down to a point in time when, in the first centuries of the Christian era, we see a mingling of the waters and the beginning of a religion and philosophy which is part of our inheritance

The rise of institutional Christianity will be traced with a view to showing in broad outline (1) how, in ecclesiastical controversy, creeds and doctrines were evolved, and (2) how the historical Roman Church became allied with the State, and attained to world power

Lastly, there will be given a brief outline of the views of representative thinkers of to-day on the spiritual outlook and the philosophical conceptions of a world more mysterious than was previously imagined

A Unique Work

We confidently believe that, covering the ground we have sketched, and in the way we have indicated, this work is unique

Many readers remain confused and bewildered in their minds about what modern science and discovery have done They are equally confused about modernist religious thought In both instances they know that the old easy beliefs are no longer tenable But what is taking their place? Many think that—in both these spheres—the subject is too difficult for them, that it is beyond them That is mostly nonsense Readers of this Outline will find out that all that is simply because the information they have picked up is too scrappy and vague to convey any definite meaning to their minds Presented in a simple, systematic way, and in clear language, the confused notions give place to a real understanding

BOOK I

SCIENCE AND MODERN THOUGHT

CHAPTER I

THE CONTRIBUTION OF SCIENCE

WE shall not attach any definite limit in time to the term "modern thought," by which we mean, broadly, men's opinions and views about life, the world they live in, and the unseen universe It is sufficient to say that within the limits of the twentieth century—as yet only thirty-three years old—some of the most startling scientific discoveries have been made, and apart from science, some of the most decisive results of research and criticism have operated in changing views generally held in the nineteenth century

Towards the end of that century (in 1885) a book was published under the title *Modern Science and Modern Thought* by a very able writer, Samuel Laing It created something of a stir, nearly twenty editions of it were printed within eight years To the general public of that day the science expounded was something new, and the "modern thought" was a little upsetting, for the way it attacked current theologies and current dogmas All that is a thing of the past, indeed, Laing's "modern" science is now very much behind the times, and its religious heterodoxy has become in our own day almost orthodoxy

Science has advanced by leaps and bounds within the last thirty years, in the section of Laing's book explaining "modern" science you will not find the word "electron," for nothing was known about that, you will look in vain for "radio activity," nothing was known about that, and nothing about "relativity" theory, or the "quantum" To-day these words spell magic, and likewise others, such as "chromosomes" and "genes" in biology, "hormones" and "ductless glands" in physiology, and so on

Again, a whole chapter was given up to combating Mr W E Gladstone's views on the inspiration of the Bible, and his theology To day you will not find any competent authority to defend Mr Gladstone's views Modern thought, then, in the twentieth century has travelled far from the thought of the late nineteenth century It is in large measure a product of the present century

ONE purpose, among others, of this work is to give the general reader as concise and plain an account as possible of the views of leading men of science in their particular fields as they have made them public in their books or lectures So, too, with leading men in scholarship, and in the realm of religion and theology and literature In other words, we shall try to expound and interpret the results of modern scientific work and thought, and show how these and other influences have tended to enlarge men's opinions and ideas

At the present day the pursuit which has the widest ramifications is science It is, perhaps, not too much to say that the whole of the modern world depends, in the first place, on science And in saying this we do not mean to refer only to the industries, commerce, means of trans-

While it is needful, then, to have some clear view of the principal results of modern science before we can understand the changes which have been effected in modern thought, it is not at all essential that the reader must study special subjects in complete and technical books and treatises. A compendious popular abridgement, an outline of broad principles, will often serve him better. This is the purpose of Book II of the present work.

The plan we propose to follow here, therefore, is to give such a summary in brief form first and foremost, and in another self-contained part of this work deal with the various branches of science in substantial detail. Quite apart from all their bearings on modern thought or their philosophic implications, in themselves the various sciences have a fascinating interest and give a rich mental satisfaction.

No one would say that the results of recent science have no philosophical implications for those who are philosophically minded. The modern realisation of *the limitations of science* is one of the most important contributions that science is making to the new world outlook. It need no longer be supposed that those elements of our experience that do not enter into the scientific scheme are in some sense illusory—so far as science is concerned it may well be that spiritual experiences, religious and æsthetic, have the importance they claim.

[Rischgitz

CHARLES DARWIN

The publication of his Origin of Species marked an epoch in world thought

[Rischgitz

THOMAS HENRY HUXLEY

The brilliant advocate of Evolution whose writings provoked Victorian theologians

§ 2

The Scientific World Picture

ONE can say that the old strictly mechanistic view of the universe which was so widely held in the Victorian era is now dead. The scientific world picture of the nineteenth century is obsolete. Matter, space and time were regarded as three independent fundamental realities; the main lines of everything were settled; there was nothing left but to fill in the details; everything worked in obedience to "iron laws"; it was an age of accepted assumptions.

For instance, the common-sense view of

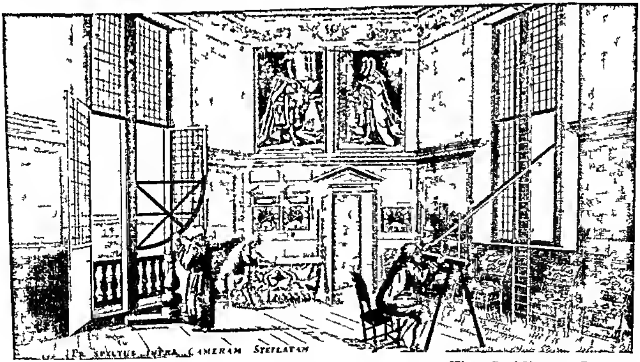
The last thirty years' research into the nature of the atom following on the discovery of the electron and the advent of relativity theory and the quantum theory of physics, have changed men s views about the nature of the universe Physical science of the last thirty years has surprised and bewildered us The atom is no longer what it was supposed to be , in the words of Sir J J Thomson the atom was thought to be a terminus beyond which it is impossible from the nature of things to penetrate The atom was regarded as indivisible impenetrable, eternal unaffected by heat, electricity or any other principal agent The inside of the atom was regarded as a territory which the physicist could never enter Well we know now how wrong all that was The sanctuary of the atom has had its doors forced to reveal the electron and the surprising phenomena of radio activity

And here we are introduced to the infinitely little—the electron so inconceivably small that neither eye nor microscope can see it At the other end of the scale of immensity we have the infinitely great we have the stars And quite unexpected is the way that an investigation and knowledge, of the one has helped the scientist to a knowledge of the other As an introduction to our world picture let us take the atom and electron first

Common Sense Confounded

Take the table on which we write set it on fire and burn it to ashes—it will be no longer a table or a bit of wood , the remains will be ashes , when these ashes are reduced to their primary states they will be chemical elements molecules and atoms But atoms in their turn, are reducible to something else All atoms we now know are composed of electrons invisible and immaterial particles if we can call them particles of electricity The ultimate nature of these electrons science does not know, beyond the fact that they manifest themselves as waves of radiant energy In finding out all this science never made a greater discovery it has revolutionised our views of the physical universe

Instead of our table consign the dead human body to the consuming heat of the crematorium



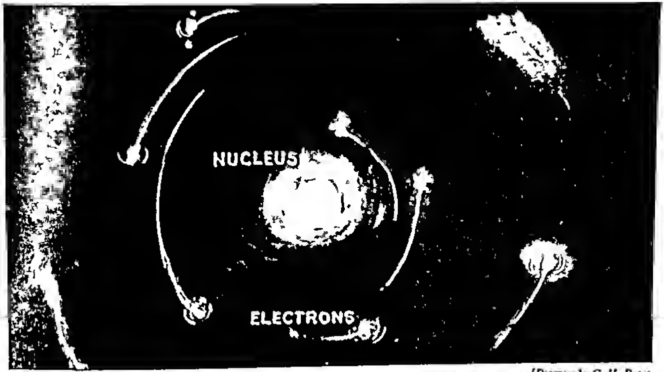
[Photo Royal Observatory Greenwich

The Octagon Room Royal Observatory Greenwich in the time of John Flamsteed appointed first Astronomer Royal in 1675 at an annual salary of £100 (Compare with photograph on page 6)

[Photo: Royal Observatory, Greenwich

WATCHING NEBULÆ AND STARS MILLIONS OF LIGHT YEARS AWAY

In the Royal Observatory, Greenwich, to-day. The 28-inch equatorial refractor. According to [illegible] the whole universe is [illegible] a thousand million times as big as the part of space which is visible through [illegible] telescopes.



[Diagram by G H Davis

The above is a purely diagrammatic drawing electrons revolving round the nucleus of the atom (at terrific speed) are likened to the revolutions of the planets in the Solar System An atom consists of a nucleus (proton) and electrons Both protons and electrons are "particles" of electricity An atom consists of these invisible electric entities, and nothing else

As will be explained in a later part of this work, the new knowledge of the atom and of electrons and protons which compose atoms has given us new knowledge of the constitution of the stars The electrons and the radio-active forces at work within terrestrial atoms are also at work in the stars and are of the same nature

and the result will be the same—a disintegration of the physical or material into something that is not obviously material substance We are all, like other things, a bundle of atoms, and atoms are composed of electrons The belief in "eternal indestructible matter," or in atoms as "rigid lumps of reality," is a thing of the past Matter, as enduring substance, is no longer regarded as a fundamental reality That is to say, when molecules and atoms that form our world of matter, are reduced to their ultimate entities we get electrons and protons, and, as we have said, these electrons and protons consist of nothing but what we call electricity, an electron is not a substantial thing in the ordinary every-day sense of the term Matter practically disappears into electrical energy Matter, all forms of ordinary substantial matter, is the outcome of the behaviour or interaction of nodes or waves of energy which we call radiations electrons and protons, in other words, matter is composed of varying combinations, recombinations, and complex arrangements of electrons and protons That is true of your own body as well as of the stars in Orion Thus the notion of "substance" has been replaced by the notion of "behaviour" The "stuff" of the world is thus envisaged as immaterial entities instead of material things

We shall see in due course more clearly, in other chapters of this book, to what far-reaching conceptions this has given rise In search of some fundamental *objective reality* in the physical universe scientists find that, if there is any objective reality at all, it is something more surprising than they had ever dreamt of In speaking of this search for purely objective truth, Eddington, after referring to the relativity theory, goes on to say "In the other great modern development of physics—the quantum theory—we have if I am not mistaken, abandoned the aim, and become content to analyse the physical universe into ultimate elements which are frankly subjective If it is difficult to separate out the subjective element in our knowledge of the external world, it must be

much more difficult to distinguish it when we come to the problem of a self-knowing consciousness, where subject and object—that which knows and that which is known—are one and the same" These words at least hint how closely man is identified with the rest of the universe, and that the universe is more mysterious than science has hitherto conceived it We do not expect the reader who has not made some study of the higher branches of modern physics to make much of this We have merely introduced the above quotation, at this stage, as an indication of the deep problems that surround the electronic theory of matter, no less than the strange problems raised by relativity theory, which we are not dealing with for the moment What—previous to the present century—seemed to be fundamental objective reality in the physical universe has faded away, and given place to conceptions undreamt of then

So much then we learn from the physicists' study of the atom and the electron Physics, in so far as it deals with the atom and the electron, introduces us, as we have said, to the most infinitely small things we know of in the universe, just as in astronomy we have the infinitely great In both cases—in the infinitely great and the infinitely small—we have sizes and velocities that stagger the imagination We shall give some of these figures later on, but just as the human mind cannot picture the infinite smallness of the world within the atom, far less can it form any kind of notion of the transcendent greatness of stellar universes And strange as it may seem the infinitely small and the infinitely great are intimately related What has the tiny world within the atom got to do with the scientific world picture which also embraces the stars and stellar universes? Everything, because the new knowledge concerning the fundamental nature of the atom and the electron gave a clue to the nature of the heavenly bodies The same kind of elements, atoms, electrons and protons, and the same complex phenomena of radioactivity characterise the stars The new knowledge of the electron gave rise to the new science which we call astrophysics, and it is from astrophysics that we get our knowledge of the constitution of the heavenly bodies, and the constitution of the stars is part of our scientific world picture We shall add to that picture and fill in some details in later chapters, it can only be done bit by bit, and in a summing up we shall see something of man's place in it and his relation to the whole, also the philosophic implications

§ 3

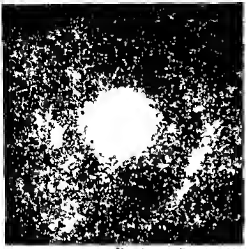
Before the World Was

NO one knows *when* the world came into being Before our earth was, there were the sun and the stars in what we call the heavens How the sun and stars came into being is a question that has not been answered with complete certainty There are hundreds of other questions which science has not been able to answer But if such questions had never been asked we should know nothing—and science knows a great deal and has gone a long way in answering what once seemed unsolvable problems, and the problems it has solved have very often raised other and deeper ones

Our planet is estimated to have come into being something like two thousand millions of years ago Æons before that the whole vast stellar universe was in existence No poet has ever ventured to picture a universe in which no terrestrial world, no world of living beings, existed—only suns and stars shining in solitary splendour in an illimitable silent universe of lifeless space And it would certainly be very difficult to suppose that the sole reason for the existence of the myriads of stars in the firmament for uncountable ages before our planet existed was to make way for the future pleasure and service of the human race, in one way or another We do not know anything about the final meaning of it all

Aristotle, we may recall, asserted that the earth formed a fixed centre to the universe, in that case, *without an earth* the universe could have had no centre Pythagoras had taught that the earth is not fixed in space but rotated on its axis every twenty four hours, and hence the alternation of day and night But *before* our planet was, there could be no alternating day and night,

MAKING THE INVISIBLE VISIBLE



[Smithsonian Report 1931

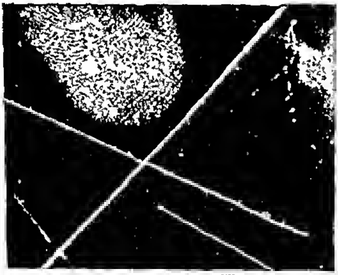
Fig 1

[Photo C T R Wilson

Fig 3

Fig 1 "Appearance of a helium atom as found by X-rays

No one has ever seen an atom or an electron, only a trace of them, as an atom is shot out from a radioactive substance it leaves a trail which can be photographed by an ingenious device, so with electrons shot out from an atom by *X-rays See figures 2 and 3*



[Photo C T R Wilson

Fig 2

Fig 2 A photograph of three or four atoms which have flashed across the field of view—giving the broad straight tracks The broken wavy trail is an electron Of this photograph Professor Eddington remarks 'I wonder if there is an undercurrent of suspicion in your minds that there must be something of a fake about this photograph Are these really the single atoms that are showing themselves—those infinitesimal units which not many years ago seemed to be theoretical con*cepts far outside any practical apprehension? I will answer that question by asking you one You see a dirty mark on the picture Is that somebody's thumb? If you say 'Yes,' then I assure you unhesitatingly that these streaks are single atoms But if you are hypercritical and say 'No, that is not anybody's thumb, but it is a mark that shows that somebody's thumb has been there,' then I must be equally cautious and say that the streak is a mark that shows where an atom has been The photograph instead of being the impression of an atom is the impression of the impression of an atom just as it is not the impression of a thumb but the impression of the impression of a thumb I don't see that it really matters that the impression is second hand instead of first-hand'*

Fig 3 shows numerous electrons which can be broken away from atoms by X-rays colliding with them

When we read that a scientist, like Lord Rutherford, has split the atom it means that he has been able to disintegrate it He actually did so, in his laboratory by using alpha particle rays as projectiles (if the reader will think of the power of X rays he will get the idea) Lord Rutherford (it has been done often since) bombarded atoms and was able to knock protons out of atoms of lighter elements The proton (a positive charge of a particle of electricity) is in the nucleus of the atom The effect of such operations is really to change one substance into another

This whole interesting subject of atoms and electrons will be fully explained in later chapters of this work It is of fundamental importance, the great discovery of our age, changing as it has done our whole notions about what matter really is

[Photo: Mount Wilson Observatory

ONE OF THE GREAT "ISLAND UNIVERSES" IN REMOTE SPACE

Prof. Barnard says: "The region of the great nebula of *Rho Ophiuchi* is one of the most extraordinary in the sky. The nebula itself is a beautiful object. With its outlying connections and the dark spot in which it is placed and the vacant lanes running to the east from it, it makes a picture almost unequalled in interest in the entire heavens." For an explanation of the nature of the nebulæ, see page 12

disturbances Then by and by these detached condensing masses become stars

At one time it was freely believed that the birth of a star was an individual event like the birth of an animal, as Eddington phrases it It was supposed that two stars long extinct, would collide and be turned into vapour by the energy of the collision , this would be followed by condensation and so a new life of a luminous body would start afresh This is an abandoned speculation, but how it all began astronomers are not able definitely to affirm Eddington pictures this conception " At some stage we imagine the void to have been filled with matter rarefied beyond the most tenuous nebula " In other words, there may have been a universe of highly disassociated atoms, a cosmic cloud of atoms evenly distributed through space, which in some way, gathered into nebulæ '

§ 4

THE layman who would understand the suggested theories of how the nebulæ came to be must first know a little about the problems that surround the constitution of the atom, the nature and phenomena of the electron, and the puzzles of radiant energies We shall not interrupt the present story to expound these subjects now , they will be dealt with in their proper place in a later chapter Sufficient for the present if we indicate the nature of the clues which are being followed up by astronomers and physicists

The nebulæ, it is suggested, may have originated from the coming together of particles of electricity that we call electrons and protons—entities or energies which are not completely understood *But there is no doubt about their existence and reality* You may look at published photographs (see page 9) although you would not understand what they were unless explained to you electrons are invisible entities, but in certain cases electrons can be driven out of atoms and the actual paths of the electrons, darting at thousands of miles a second, can be photographed as they are seen through faint mists in closed tubes We call them particles but we must remember that no one can yet say precisely what an electron is it is an activity of a mysterious kind, and no familiar conception of its reality can be pictured

In the ultimate analysis of matter, as we have already explained, everything is reducible to atoms, and *all* atoms are composed of these tiny, invisible, electric particles Thus, as Eddington says, " the road to a knowledge of the stars leads through the atom , and important knowledge of the atom has been reached through the stars " So the theory stands in the light of recent scientific knowledge To pursue it further here would be to enter into the deeper questions raised by recent discoveries, and we shall not complicate this preliminary summary by anticipating what belongs to a later chapter

Eddington's Picture

We need say no more, for the present, on this subject We are here merely giving a short answer to the question *how* the stars were born and how the earth came to be Professor Eddington has given us a lucid and concise summary

" Looking back through the long past we picture the beginning—a primeval chaos which time has fashioned into the universe that we know Its vastness appals the mind , space boundless though not infinite, according to the strange doctrine of science The world was without form and almost void But at the earliest stage we can contemplate, the void is sparsely broken by tiny electric particles, the germs of the things that are to be , positive and negative they wander aimlessly in solitude, rarely coming near enough to seek or shun one another They range everywhere so that all space is filled, and yet so empty that in comparison the most highly exhausted vacuum on earth is a jostling throng In the beginning was vastness solitude, and the deepest night Darkness was upon the face of the deep, for as yet there was no light

' The years rolled by, million after million Slight aggregations occurring casually in one place and another drew to themselves more and more particles They warred for sovereignty, won and lost their spoil, until the matter was collected round centres of condensation leaving

[Photo Mount Wilson Observatory

SPIRAL NEBULA IN URSA MAJOR

The spiral nebulæ, the most distant objects in the sky are great masses of whirling gaseous matter From spiral nebulæ which are of colossal size, stars are born The first distinct appearance of stars is seen in this photograph The great nebulæ contain enough matter to make a thousand million suns

vast empty spaces from which it had ebbed away Thus gravitation slowly parted the primeval chaos These first divisions were not the stars, but what we should call 'island universes,' each ultimately to be a system of some thousands of millions of stars The spiral nebulæ acquired rotation (we do not yet understand how) which bulged them into flattened form and made them wreathe themselves in spirals Their forms, diverse yet with underlying regularity, make a fascinating spectacle for telescopic study

"As it had divided the original chaos, so gravitation subdivided the island universes First the star clusters, then the stars themselves were separated And with the stars came light, born of the fiercer turmoil which ensued when the electrical particles were drawn from their solitude into dense throngs"*

Our planet was born of the sun, so it is thought at present, and the sun, like other suns and stars, is the offspring of one of the rotating nebulæ we have been speaking about That answer, of course, is only throwing the question further back We are told that "no doubt can be entertained that the genesis of the stars is a single process of evolution which has passed and is passing over a primordial distribution" Where did this primeval gaseous distribution come from that gave birth to the nebulæ which shone in the sky myriad million years before the earth came into being, and is still giving rise to stars which we may actually see in the process of formation?

Jeans's Suggestion

There is no answer, only conjecture We may mention one suggestion put forth by Sir James Jeans After showing that no hypothesis explains the spiral arms of the nebulæ, he says

"Each failure to explain the spiral arms makes

* Eddington's *Science and the Unseen World*

THE WHIRLPOOL NEBULA (in *Canes Venatici*) [*Photo: Mount Wilson Observatory*

This striking spiral nebula is viewed nearly full on. The sequence of transition and development from nebulous matter to star-clouds and to stars can be traced in the study of various nebulæ. Our telescopes show us both the nebular fringes and the stars and we can almost study the actual process of birth.

it more and more difficult to resist a suspicion that the spiral nebulæ are the seat of types of forces entirely unknown to us, forces which may possibly express novel and unsuspected metric properties of space The type of conjecture which presents itself, somewhat insistently, is that the centres of the nebulæ are of the nature of 'singular points,' at which matter is poured into our universe from some other, and entirely extraneous, spatial dimension, so that, to a denizen of our universe, they appear as points at which matter is being continually created " *

This answer is only a scientific speculation In the above passage note that Jeans uses the phrase, " matter poured into our universe from some other " He considers that the difficulty of explaining the shape of the spiral arms in the great nebulæ may be solved by the discovery that the centres of such nebulæ are taps through which matter pours from some other universe into ours That, again, but throws the question yet another step further back.

§ 5

A GREAT deal of what we have been saying may be obscure to the uninitiated reader, it will be clearer after he has read the sections on Astronomy We begin to see in what way astronomy has contributed to modern scientific thought It has vastly widened the aspects of cosmogony, that is, the theory of the origin of the universe and its inhabitants, it has given us a great number of new facts and such inferences from them as have extended the scientific outlook As Sir James Jeans has said, " Astronomy is a science in which exact truth is ever stranger than fiction, in which the imagination ever labours panting and breathless behind the reality, and about which one could hardly be prosaic if one tried " One other thing impresses our minds—the insignificance of our own little planet

It is some centuries now since men regarded the earth as the centre of the universe and terrestrial life as the central fact of the universe The universe, taken in the widest meaning of the term, is in size far beyond the comprehension the human mind, astronomers are bold enou to guess figures, but even their estimates, so are they, convey nothing but bewilderment to

Many Universes

We sometimes apply the term " universe " t our own stellar system, of which the sun is member, and the huge constellation of which we call the Milky Way, but of course it i only a sub universe or " *our* universe "

As we have seen, there are many other " universes " that lie at immense distances altogether outside of it, thousands of universes each of the same order of magnitude as this one of ours Modern astronomy has greatly enlarged our views here, opening up new vistas and leading to new conclusions Not only is our vision of the universe continually expanding (says Jeans) " but it is expanding at an ever-increasing rate " To confine ourselves to the range of the biggest telescope we have, we are told that the remotest objects visible in the heavens " are so distant that light, *travelling* 186,000 *miles a second*, takes about 140 million years to come from them to us " Dr Hubble ' estimates that the whole universe is about a thousand million times as big as the part of space which is visible in this telescope "

When astronomers speak about stellar distances they speak in terms of a ' light-year " This term means the distance that light travels in a year namely six million million miles Nothing travels faster than light (which travels at the rate of 186 000 miles a second) The nearest of the heavenly bodies to us is the moon, which is about 240 000 miles away, the sun is about 93,000 000 miles away, the nearest star is Alpha Proxima, and it is about *four ligh years* away Imagination fails us when we are told that there are nebulæ which are more than *a hundred million light years away* " They perhaps represent regions where the once much scattered matter of the universe became gathered together, and in the course of time became concentrated into glowing stars or suns " These are staggering figures, and no human

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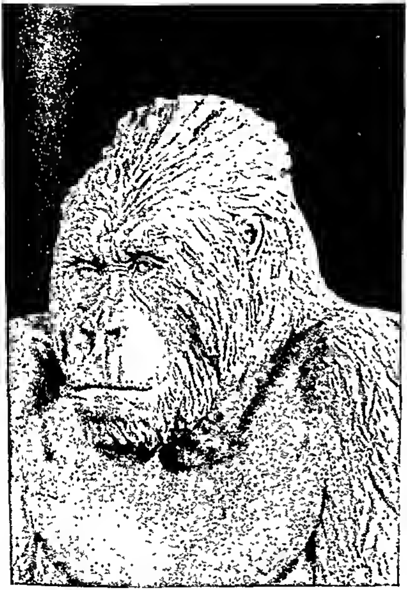
* Jeans's *The Universe Around Us*

THE "WHIRLPOOL NEBULA" (in Canes Venatici)

THE GORILLA IS MAN'S NEAREST RELATION



[Courtesy of the Illustrated London News

The "benign expression" of "The Old Man of Mikeno": a portrait bust by Mr. Akeley, for casting in bronze, that seems to disprove the gorilla's reputation for ferocity. A significant comparative study.

[From the model by J. H. McGregor

Pithecanthropus erectus, the ape-man of Java. Antiquity estimated at 500,000 years. See page 73 (Part II).

[From the model by J. H. McGregor

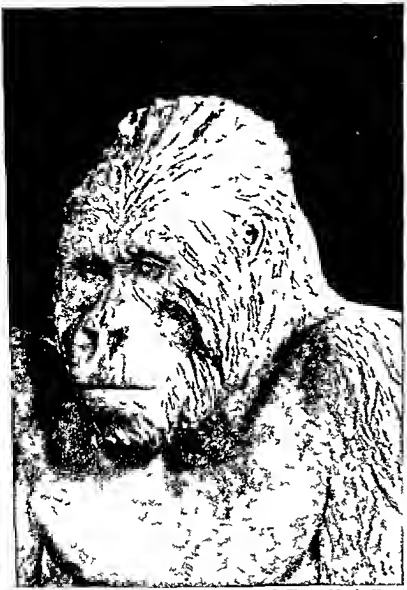
The Neanderthal man, inhabiting the Dordogne region of central France. Antiquity estimated as between 40,000 and 25,000 years. See page 73 (Part II).

of the really fundamental physical conditions of the universe in which we live is a growth of the last quarter of a century" (Jeans).

We may now leave this short summary of twentieth-century physics and astronomy for another glimpse of the scientific world-picture of to-day. In Book II, in the section devoted to Physics, we shall see how our knowledge of the atom, the electron, and such things as we have been speaking about is arrived at.

We shall also see in the Astronomy section (Book II) how astronomers arrive at the ages of the stars, what goes on inside a star, the life-story of stars, how they go through a cycle of life, and die, and what the probable final state of the sun and the earth will be.

THE GORILLA IS MAN'S NEAREST RELATION



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Meantime let us see what conclusions twentieth-century science has arrived at on the absorbing question of the Origin and Antiquity of Man. The rapidity of fresh discoveries in the last two decades bearing on the Antiquity of Man is astonishing. As Sir Arthur Keith has said, it is difficult to keep abreast of new discoveries in this field. The present century has also thrown some new lights on evolution problems.

We may suppose that science has now given a conclusive answer to the question of the origin of man. It is generally argued that he emerged from a generalised stock common to him and the anthropoid (man like) apes. It is not contended that it is from any existing form of anthropoid apes that man took his origin. Each, however, ape and man would seem to branch from a common stem on the evolutionary tree of life.

This subject will be considered in the next Chapter of Book I, where we shall continue this preliminary summary of the discoveries which the present century (in particular) has contributed to what we call modern scientific thought.

(To be continued on page 65.)

[From the reconstruction by J. H. McGregor

The skull of a Piltdown Man: the remains were found in Sussex in 1911. It is suggested that Piltdown Man lived 100 000 to 150 000 years ago.

[After J. Leon Williams

THE PILTDOWN (SUSSEX) DISCOVERY

Scene of the world famous discovery of the Piltdown Dawn Man of Sussex. The photograph shows Dr. A. Smith Woodward and Dr. Charles Dawson (left) screening and washing Piltdown gravel in search of more fragments of the skull and teeth. At the right a workman stands on the exact spot of the original discovery (1911).

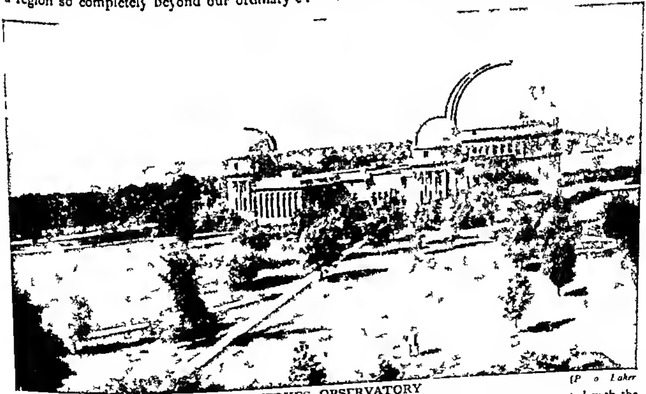
MODERN SCIENCE

CHAPTER I

ASTRONOMY

§ 1

THERE is no science which appeals so greatly to the imagination as Astronomy From whatever point of view we regard it astronomy is the most impressive and the most romantic of the sciences Its subject matter is the whole stellar universe its boundaries are those of space and time Amongst the objects it studies are the strangest that ever occupied the human imagination no other study takes us into a region so completely beyond our ordinary experience except perhaps the atom in the one case we are dealing with the infinitely great and in the other with the infinitely small Both hold the deepest mysteries But let us plunge into our subject forthwith beginning with a general survey of the heavens All in good time we shall come to the great problems that hold such fascination for astronomers and laymen alike—such questions as the origin and the nature of the heavenly bodies the birth age and death of stars in a word in what really is going on in the stellar



[P o Laker

YERKES OBSERVATORY

It was founded and endowed by Charles Tyson Yerkes an American financier It is connected with the University of Chicago and is situated at Lake Geneva Wisconsin about 65 miles north west of Chicago It contains a 40 inch refracting telescope the largest in existence

worlds Considered in its human aspect, astronomy is the greatest of human monuments The profoundest achievements of the human reason have gone to the making of it, the most exquisite skill, the most admirable patience, the greatest mathematical genius, and the noblest and most disinterested passion for the truth

It is with more than a sense of awe that most of us contemplate these myriad twinkling, glittering points on a bright, starlit night the immense galaxy of them shining in the unsounded depths of space, the great immense stillness, the felt mystery, the sense of vastness and majesty

There is no occasion to add to what we have said in Book I about the vastness of space and the inconceivable immensities of the stellar universe We speak of "our" universe, but, as we shall see, it is only one among other stellar universes Beyond the Milky Way there are myriads of other star systems The particular stellar universe, the galactic system, to which our sun belongs contains about thirty thousand million stars The sun itself is rather a small and ordinary star in this family, and is perhaps not unique in having a system of its own The sun is a star, and the stars are suns because they shine by their own light The sun is the name of a star, but so dependent is all human life on it that we think of it as the Sun, and not as a star Even the nearest stars are at unimaginable distances from us Our sun, with its attendant planets circulating round it, forms a compact little system that floats in an inconceivable isolation

If we could be transported in some magical way to an immense distance in space above the sun, we should see our solar system as it is drawn in the diagram on page 40, except that the planets would be mere specks, faintly visible in the light which they receive from the sun If we moved still farther away, billions of miles away, the planets would fade entirely out of view and the sun would shrink into a point of fire, a star Our sun looks big, in comparison with other stars, simply because of its comparative nearness to us

The universe is a stupendous collection of millions of stars or suns, some of which may have planetary families like ours

The Stars

A glance at a photograph of star-clouds w[illegible] tell at once that it is quite impossible to [illegible] the stars The fine photograph reproduced [illegible] page 33 represents a very small patch of th[illegible] pale-white belt, the Milky Way, which spans t[illegible] sky at night It is true that this is a particularly rich area of the Milky Way, but the entire belt of light has been resolved in this way into masses or clouds of stars (*See also pages* 28 *and* 29)

Yet these stars are separated by inconceivable distances from each other, and it is one of the greatest triumphs of modern astronomy to have mastered, so far, the scale of the universe For several centuries astronomers have known the relative distances from each other of the sun and the planets If they could discover the actual distance of any one planet from any other, they could at once tell all the distances within the solar system The method of measuring stellar distances we shall explain presently Meanwhile, astronomers have found that the nearest star to the earth, a comparatively recently discovered star, is *twenty-two billion miles away* Only thirty stars are known to be within a hundred billion miles of us

This way of measuring does not, however, take us very far away in the heavens There are only a few hundred stars within five hundred billion miles of the earth, and at that distance the "shift" of a star against the background (parallax, the astronomer calls it) is so minute that figures are not too certain At this point the astronomer takes up a new method He learns the different types of stars, and then he is able to deduce more or less accurately the distance of a star of a known type from its faintness He, of course, has instruments for gauging their light As a result of twenty years work in this field, it is now known that the more distant stars of the Milky Way are at least a hundred thousand billion miles away from the sun

Our sun is in a more or less central region of our universe, or a few hundred billion miles from the actual centre The remainder of the stars, which are all *outside* our solar system, are spread out, apparently, in an enormous disc-like collection, so vast that even a ray of light, which

multitude of meteors . in other words, all bodies whose movements in space are determined by the gravitational pull of the sun For the moment let us restrict ourselves to the solar system

Vast as is the solar system, it is excessively minute in comparison with the stellar system, the universe of the stars, which is on a scale far transcending anything the human mind can apprehend The vast stellar system lies outside our system of sun, planets, and satellites

Thanks to our wonderful modern instruments and the ingenious methods used by astronomers, we have to-day a remarkable knowledge of the sun, and we shall begin our story with it

§ 2

The Sun

THE sun is a fairly average star There are some stars smaller and cooler than the sun, and there are many stars very much bigger and very much hotter The sun is not a distinguished member of the heavenly hosts , at the same time it is not particularly insignificant From the point of view of a stellar astronomer, the sun calls for no particular comment Judged by terrestrial standards, however, it is, in all respects, prodigious

The diameter of the sun is 865,000 miles, which means that its volume is well over a million times greater than the volume of the earth It is not as dense as the earth, however, so that its mass is only 330,000 times the mass of the earth The most obvious and striking feature of this immense globe of gas, is that it is continually pouring out energy in the form of light and heat

Each square inch of the sun's surface radiates as much energy as would be developed by a 50 h p engine The sun has been radiating energy at this rate for millions of years and can continue to do so for millions of years to come This stupendous fact would surely prompt even the most casual reader to ask, where does this energy come from ? We may remark that before the beginning of the present century the source of the light and the heat the sun and stars gave forth was not known

We shall see what the suggestions of astronomers about the sources of this energy are presently. Meantime, let us look at the sun as an object in the heavens

Look at the figure of the sun in the frontispiece The picture represents an eclipse of the sun , the dark body of the moon has screened the sun's shining disc and taken the glare out of our eyes , we see a silvery halo surrounding the great orb on every side It is the sun's atmosphere or " crown " (*corona*), the most beautiful of all the sun's features It is visible only at the moment of total eclipse As the moon's disc advances there comes a moment when the whole of the bright face of the sun is covered At that moment the corona flashes out —vast pearly white wings and streamers surrounding the sun like some gigantic halo, stretching for thousands of miles into space Probably much of its light is sunlight reflected from particles of dust

We next notice in the illustration that at the base of the halo there are red flames peeping out from the edges of the hidden disc When one remembers that the sun is 865,000 miles in diameter, one hardly needs to be told that these flames are really gigantic We shall see what they are presently.

Three Regions

The astronomer has divided the sun into definite concentric regions or layers These layers envelop the nucleus or central body of the sun somewhat as the atmosphere envelops our earth It is through these vapour layers that the bright white body of the sun is seen About the innermost region, the heart or nucleus of the sun, astronomers can only speculate, but as we shall see they are not without ideas The central body or nucleus is surrounded by a brilliantly luminous envelope or layer of vaporous matter which is what we see when we look at the sun, and which the astronomer calls the *photosphere*

It is from the photosphere that we have gained most of our knowledge of the composition of the sun Examination of the photosphere shows that the outer surface is never at rest Small bright cloudlets come and go in rapid succes

sion, giving the surface, through contrasts in luminosity, a granular appearance. Of course, to be visible at all at 93 000 000 miles the cloudlets cannot be small. They imply enormous activity in the photosphere. If we might speak picturesquely, the sun's surface resembles a boiling ocean of white hot metal vapours. We have to day a wonderful instrument, which dilutes, as it were, the general glare of the sun, and enables us to observe these fiery eruptions at any hour. The " oceans " of red hot gas and white hot metal vapour at the sun's surface are constantly driven by great storms. Some immense energy streams out from the body or nucleus of the sun and blows its outer layers into gigantic shreds, as it were.

The actual temperature at the sun's surface, or what appears to us to be the surface—the photosphere—is of course, unknown but careful calculation suggests that it is from 5 000° C to 7 000° C. The interior is vastly hotter. We can form no conception of such temperatures as must exist there. Not even the most obdurate solid could resist such temperatures, but would be converted almost instantaneously into gas. But it would not be gas as we know gases on the earth. We can only infer this state of matter. It is beyond our power to reproduce it.

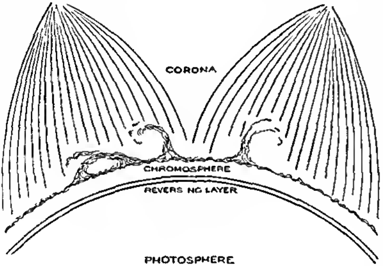


Diagram showing the main layers of the Sun

Sun Spots

The most striking characteristic of the photosphere is the *sun spots*, which look like dark holes in the sun. They vary greatly in size, and also in duration. A good sized sun spot measures many thousands of miles across, and could easily engulf several bodies the size of the earth. Some of these spots last for a month or more, some for only a few days. If they are watched attentively from day to day, they are seen to pass slowly across the face of the sun. As all the spots move in the same direction, it is obvious that the sun must be rotating. The sun does not rotate as a whole, however, as a solid body would do. In the neighbourhood of the sun's equator a spot makes a complete revolution in about twenty-five days. North and south of the equator the spots move more slowly, taking about twenty seven days for a complete revolution.

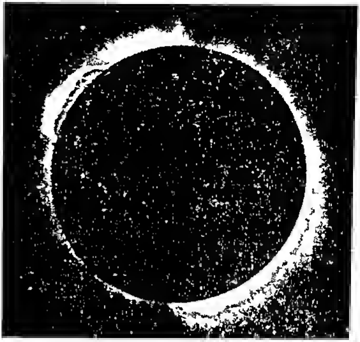
A curious and unexplained characteristic of sun spots is that they recur in cycles. Sunspot activity waxes and wanes in a very definite manner. After the maximum of sun spot activity has been reached, the number of sun spots gradually declines to a minimum and then again gradually rises to a maximum, the complete cycle taking a little over eleven years.

This curious phenomenon seems to affect the earth's magnetism, for the magnetic storms we experience pass through a similar cycle. The displays of the aurora borealis, also seem to vary in accordance with sun spot activity. Recent investigation proves that sun spots actually are magnetic, two adjacent sun spots behaving like the opposite poles of a horseshoe magnet. Even when the telescope reveals a sun spot as isolated, it is in reality, coupled with another, invisible spot having the opposite kind of magnetism to its own. But the origin of sun spots and the processes within the sun which

cause sun spot cycles still remain complete mysteries

Immediately above the photosphere is a transparent layer of comparatively cool gases, called the "reversing layer," the layer being about 500 miles in depth The gases in this layer are composed of a considerable number of the elements known on earth

Above this shallow layer is another called the *chromosphere* At times of solar eclipse, when the bright photosphere is hidden from us by the moon, the chromosphere may be clearly seen as a strip of pink red light Its dimensions are considerable, for it has a depth of from 5 000 to 10,000 miles This great layer of gases is in a state of tremendous agitation It frequently shoots out huge flaming masses, the so called 'prominences' Some of these great flames extend to half a million miles above the sun's surface, and are projected upwards at the rate of 100 miles per second During an eclipse, they become visible, and many excellent photographs of them exist

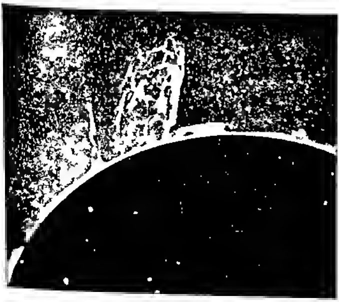


[Photo Royal Observatory Greenwich

Solar prominences seen at total solar eclipse May 29 1919 The small Corona is also visible

Interior of the Sun

In this description of the chief features of the sun we have confined our attention to what can be observed by ordinary means But we are not limited to such means A vast amount of information has been obtained about the sun, and, indeed, about the whole stellar universe, by analysing the light that we receive The science of light analysis is one of the most important in the whole of astronomy and physics We learn, first of all, that the stars are composed of the same kind of elements known to us on earth, they are composed of a collection of atoms of different elements—hydrogen, nitrogen, carbon, iron and many rarer things—and all these elements, as we know, are fundamentally electrical in nature, made up of electrons and protons—unit particles of electricity, about which we shall have a good deal to say later



[Photo Kodaikanal Observatory South India

Solar prominences seen during a total eclipse of the Sun The flames are sometimes hundreds of thousands of miles high

It is the aggregate of these elementary atoms that constitutes the mass of a star Atoms, and electrons which compose atoms, and are also sometimes in a free state with their separate existence, are in violent motion

Terrific atomic storms are raging in this super mundane world, and in a supermundane way Eddington pictures the interior of a star as "a hurly burly of

atoms, electrons, and ether-waves Dishevelled atoms tear along at 100 miles a second, their normal array of electrons being torn from them in the scrimmage The lost electrons are speeding 100 times faster to find new resting places Let us follow the progress of one of them There is almost a collision as an electron approaches an atomic nucleus, but putting on speed it sweeps round in a sharp curve Sometimes there is a side slip at the curve, but the electron goes on with increased or reduced energy After a thousand narrow shaves, all happening within a thousand millionth of a second, the hectic career is ended by a worse side-slip than usual The electron is fairly caught and attached to an atom But scarcely has it taken up its place, when an X ray bursts into the atom Sucking up the energy of the ray the electron darts off again on its next adventure

And what is the result of all this bustle? Very little The atoms and electrons for all their hurry never get anywhere they only change places The ether-waves are the only part of the population which accomplish anything permanent Although apparently dashing in all directions indiscriminately, they do on the average make a slow progress outwards Slowly the ether waves leak outwards as through a sieve An ether-wave hurries from one atom to another, forwards, backwards, now absorbed now flung out again in a new direction, losing its identity, but living again in its successor With any luck it will, in no unduly long time (ten thousand to *ten million years, according to the mass of the* star) find itself near the boundary It changes at the lower temperature from X rays to light-rays, being altered a little at each re birth Perhaps it may in the end reach some distant world where an astronomer lies in wait to trap *it in his telescope and extort from it the secrets* of its birth place"

That then, is how the ether waves find their way out surging through the jostling crowd in this tremendous vortex, seeking for freedom, and "after a long journey through space they warm us and gladden us when we walk in the sunshine"

All this may seem very *complicated* and bewildering to the lay reader, but it will become clearer when we come to the science of physics

The astronomer's present view of the sun, then, conceives it as this very complicated sort of gaseous sphere It is a seat of terrific energy. How is this energy maintained?

How the Sun's Energy is Maintained

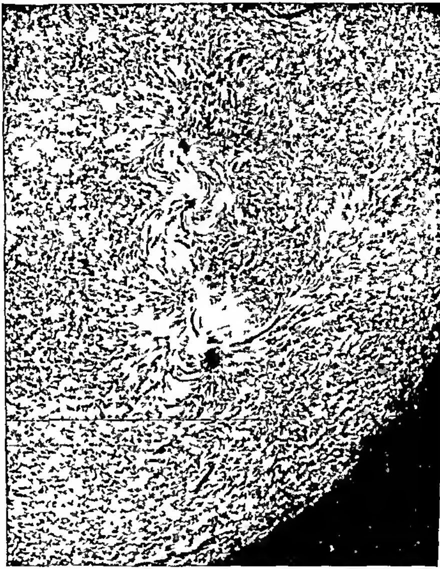
It is only quite recently that a plausible answer has been given to this question The answer has been arrived at slowly, simply because no known sources of energy on earth could possibly account for the sun's radiation If, for instance, the sun consisted of something like pure coal burning in oxygen, it would long ago have burnt itself out It is not a question of combustion Such a sun could not provide more than a millionth part of the radiation that the sun has already expended The discovery of radium and of other radio active elements suggested that the sun might be radio active The amount of energy that streams from radium is certainly enormous, and it can be shown that a sun made of pure radium would be able to radiate as much energy as the sun is observed to radiate But it could not keep it up A radium sun would only last a few thousand years, whereas the life of the sun must be reckoned in millions of millions of years

A theory of the sun's radiation that once enjoyed great favour was the famous "contraction hypothesis" put forward by Helmholtz Helmholtz pointed out that the outer parts of the sun *must* be continually gravitating towards the centre, the sun must, in fact, be slowly shrinking The principles of mechanics inform us that this shrinkage must be attended by the evolution of heat Is it possible that the sun's heat is maintained in this way?

The answer to this question can be *provided* by calculation If we assume that the sun was originally a large diffuse mass of gas, we have to calculate how long it would take to shrink to its present size The answer turns out to be in the neighbourhood of twenty million years This is altogether too short a time for the life of the sun The sun is vastly older than the earth, and the age of the earth cannot be much less than 2,000

million years. It is obvious, therefore, that the sun's contraction cannot be responsible for more than a small fraction of the total amount of energy that it has radiated.

The present explanation of the sun's radiation rests upon the new theory of the atom — the so-called electron theory. According to that theory, as we have seen, an atom is built up of extremely minute electric particles. They are of two kinds, the positive and the negative. The atoms of every sort of substance are supposed to consist wholly of greater or smaller numbers of these "electrons," as they are called.



[Photo Mount Wilson Observatory

SUN VORTICES

This Hydrogen photograph shows the solar vortices of the Sun — a wonderful picture of whirlwinds and commotion on the Sun's surface, whose temperature is about 6000 degrees absolute, a mere nothing compared with the temperature at the centre of the Sun, which is 40 million degrees.

Since all the matter in the universe is composed of atoms, which in turn are composed of electrons, all matter is electrical in its nature.

We are to picture the sun, therefore, as being built up, in reality, of unthinkable numbers of these minute positive and negative electrons. In the conditions of temperature and pressure that obtain on earth, positive and negative electrons, owing to the way they are grouped inside an atom, never come into contact with one another. They always maintain their distance, which is actually very great relatively with their size.

At the Centre

But altogether different conditions prevail in the sun. At the centre of the sun, for example, the temperature is 40 million degrees. The hottest furnace on earth does not even remotely approach this temperature. In such extraordinary conditions, it is quite reasonable to suppose that phenomena quite unknown on earth may make their appearance. It is very unlikely, for example, that atoms, as we know them on earth, could continue to exist. At such temperatures they would be disrupted, and we must regard the centre of the sun as an inconceivable commotion of positive and negative electrons no longer united in little groups to form atoms, but leading separate existences.

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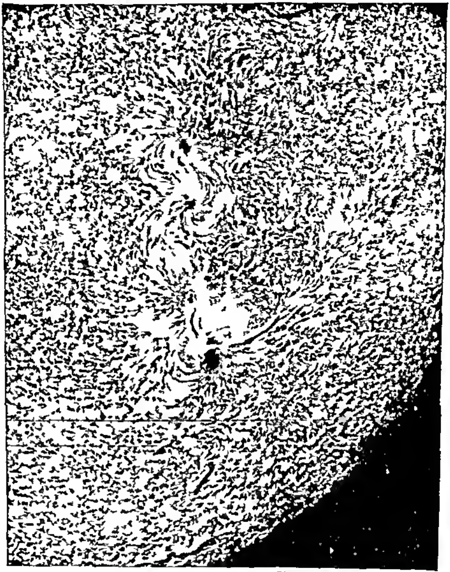

[Photo Mount Wilson Observatory

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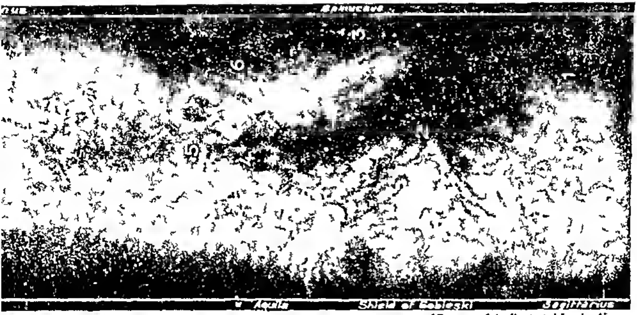


[Courtesy of the Illustrated London News

...graphs taken by M. Lucien Rudaux. This remarkable chart was made by M. Rudaux by combining fifty photo-
...gittarius, (2) Shield of Sobieski, (3) Ophiuchus, (4) Aquila, (5) Aquila, (6) Aquila and Ophiuchus,

CHAPTER II

THE STARS

§ 1

IF we gaze at the sky on a clear starry night, the number of stars we see seems to be beyond counting. They are all, of course, beyond our solar system. We seem to be gazing at an immense multitude of stars. It comes as *something of a shock, therefore, to be told that* we can see only about 3,000 stars with the naked eye. Yet if we count the stars we shall find that we cannot see more, and we must have pretty good eyesight to see even that number.

In the time of the ancient Greeks a catalogue was drawn up giving the positions of all the brighter stars that can be seen from Mediterranean latitudes. This catalogue contains 1,080 stars. The modern ideas of the immensity of the stellar hosts only came into existence with the invention of the telescope. Even a small telescope adds enormously to the number of the stars. And when we reach the limits of visibility possible through our biggest telescopes, we can still go further with the aid of the photographic plate. For the photographic plate placed at the eye-piece of a telescope stores up light impressions hour after hour, the impress becoming stronger and stronger, whereas no amount of staring at an object too faint to be seen will make it visible.

Within the immense volume of space open to our telescope there lies a great variety of objects. We *have, for instance, single* stars, double stars, triple stars, and a variety of other objects. A double star consists of two stars very close together, and revolving round one another. Similarly, in a triple star, we have three stars close together, and revolving in accordance with their mutual attractions. And there are more complicated systems still.

Then there are the so-called "moving clusters" where we have a number of stars at immense distances apart, but travelling through the heavens in company, all in the same direction. The constellation of the Great Bear is an example of such a cluster. Indeed, most of the conspicuous groups of stars in the sky are clusters of this kind.

Then there are the globular clusters where, as the name implies, we have a mass of stars

forming a cluster of an almost globular shape These globular clusters are very curious objects They are all about the same size, and they all seem to be confined to the same region of space The stars composing them are packed much closer together than the ordinary run of stars, each globular cluster containing hundreds of thousands of stars And they are moving through the heavens much more quickly than stars usually move

The Constellations

Thomas Carlyle once said "Why did not somebody teach me the constellations and make me at home in the starry heavens which are always overhead, and which I don't half know to this day?" Doubtless thousands of men and women have felt the same thing, if they have not expressed the thought in so many words By constellations we mean certain groupings of stars which are formed of the nearer and conspicuous stars The names of the constellations were borrowed from fancy or fable, and mainly from Greek mythology The constellations are divided into northern, southern, and zodiacal constellations

The forty-nine southern constellations include Orion, perhaps the grandest constellation, because of the starry jewels it contains—Orion, the Hunter of mythology, in this neighbourhood we find the star Sirius, the Dog Star, the brightest star in the sky

The twenty-eight northern constellations include Ursa Major (the Great Bear, seven stars of which go by the name of the "Plough"), Cassiopeia (the Lady of the Chair), and Pegasus (the Winged Horse), etc

The twelve zodiacal constellations include Ram, Bull Twins, Crab Lion, Scorpion, etc The Pleiades is a small group of stars ("Seven Sisters") in the constellation Bull (Taurus)

Jeans says that "physical study confirms the suspicion that groups such as those mentioned are, generally speaking, true families, and not mere accidental concourses, of stars The stars of any one group, such as the Pleiades, not only show the same physical properties, but also have identical motions through space, thus journeying perpetually through the sky in one another's society" We may think of the friendship of the stars

Measuring Distances

The problem of the distance of the stars was solved by utilising the fact that the position of an object against a distant background seems to alter when we survey that object from different positions This is one of the commonest facts of observation Travellers in a train notice that some distant object, a tree or a church spire, gradually changes its position against the still more distant background The more distant the object, the more slowly it seems to change its position By measuring this change in position we can calculate the distance of the object

Now this principle can be applied to the stars For the earth moves round an orbit whose diameter is 186 million miles If two observations on a star be made at an interval of six months, then the star has been observed from two positions separated from one another by a distance of 186 million miles The star, therefore, should seem to have shifted its position in the sky This effect was looked for very shortly after the discovery that the earth went round the sun But the effect was not observed What are we to conclude from this?

Some of the early astronomers concluded that the earth did not go round the sun Others of them concluded that the stars were at such immense distances that, with the imperfect measuring instruments of those days, the effect was imperceptible We now know that this latter explanation was the right one

It was not until nearly half way through the nineteenth century that the distance of a star was first determined This feat was performed almost simultaneously by three men, Bessel, Struve, and Henderson. Each man worked on a different star They used the finest instruments available, but, even so, the distances of the stars are so enormous and the resulting measurements so delicate that only one man, Bessel, obtained an accurate result The other results had an error of, in one case, 25 per cent, and, in the other case, of over 100 per

SUN SPOTS [Courtesy of The Illustrated London News

They look like dark holes in the Sun; they vary greatly in size and also in duration. A good sized sun
spot measures many thousands of miles across, and could engulf several bodies the size of the earth. Their
origin is a mystery; the curious phenomenon seems to affect the earth's magnetism, for the magnetic storms we
experience pass through a similar cycle to those of sun spots.

by this method The method suffices, with fair accuracy, to measure distances up to about 500 light-years, but for the much greater distances of various stars and of the nebulæ we have to use other methods These other methods, however, all rest upon the knowledge we have gained, in the way described, of the distances of the nearest stars

§ 2

FROM a knowledge of stellar distances we can calculate other characteristics of the stars We can, for instance, determine the actual brightness of a star if we know its distance We know that some stars seem brighter than others Are they really brighter, or are they merely nearer to us? A knowledge of their distances enables us to answer this question

Star Characteristics

We find that the stars do actually differ very greatly in absolute brightness Some stars are a million times brighter than others We can also find at what rate a star is moving if we know its distance For all the stars are in motion, although this motion, owing to their distances, is so difficult to detect that the stars are often called the "fixed" stars

All the astronomical bodies are in motion, the term "fixed" is only a figure of speech "The earth performs its yearly journey round the sun at a speed of about 18½ miles a second, which is about 1,200 times the speed of an express train The sun moves through the stars at nearly the same rate—to be precise, at about 800 times the speed of an express train And, broadly speaking, the nearer planets and the majority of the stars move with similar speeds We shall not obtain a bad approximation to the truth if we imagine that all astronomical bodies move with exactly equal speeds, let us say, to fix our thoughts, a speed equal to 1 000 times the speed of an express train" (*The Universe Around Us*)

When we speak of "fixed" stars, then, it is only in a relative sense The rate of apparent motion is a matter of relative distance The nearer to us the star, the quicker it seems to move across the sky, the greater the distance from us, the slower is the apparent motion None of the stars are just points of light absolutely "fixed" in the sky We call them fixed because it was once thought so, and they are called "fixed" now to distinguish them from the planets or *wandering* stars Being relatively near us, "the planets move across the sky so rapidly that it is quite easy to detect their motion from night to night, and even from hour to hour; the stars move so slowly that, except with telescopic aid, no motion can be detected from generation to generation, or even from age to age Even the conspicuous constellations in the sky, which on the whole are formed of the nearer stars, have retained their present appearance throughout the whole of historic times The contrast between the planets which change their positions every hour and the stars which fail to show any appreciable change in a century, gives a vivid impression of the extent to which the stars are more distant than the planets" (*Universe Around Us*)

Before we pass on to some more advanced problems of astronomy, and astrophysics, which deals with the matter and the nature, and the life story, of the stars, we shall continue the story of the stars, the planets, and other heavenly bodies as we see them in the night sky The sun does not permit us to think of them as being there in the day time also The sun "puts out" the light of stars by day simply because, being so much nearer to us, its light is more overpowering By night on a sufficiently extensive plain we see one-half of the whole starry sphere, and the observer, but for the obstacle of the earth on which he stands, would see stars everywhere below as well as above him

There are stars enormously larger than the sun In actual brightness Sirius (or the Dog Star) has twenty-six times the luminosity of the sun it is the brightest star in the sky, and is 51 million million miles away Astronomically speaking, the sun is "close at hand"—it is 93 million miles away—and the light that leaves it reaches us eight minutes later, whereas the light that reaches us from the nearest "fixed" star, which is *Proxima Centauri*, left it about four years before it reaches us It has been remarked that most of the stars that we see with the unaided

eye we see by the light that left them in the seventeenth century. We repeat that light travels at the rate of 186,000 miles a second, which is six million million miles in a year. In one second light would travel seven and a half times round the earth. We are speaking about stars that we can see with the unaided eye but what of stars we can see and nebulæ we can discern by a powerful telescope? The nearest of the nebulæ, says Eddington, is such that light takes 900,000 years to cross the gulf between us. The light which reaches us from the most distant bodies started over a million years ago—not merely before the dawn of civilisation but long before the human species existed on this planet of ours.

Star Distances

We have spoken of the brightness of Sirius, but even Sirius is not the most luminous of known stars. The most luminous of known stars emits 300,000 times as much light and heat as our sun. If this star replaced our sun the whole earth would immediately dissolve into vapour. At the opposite extreme the *least* luminous star known emits only one fifty thousandth part of the light of the sun. If our sun's radiation ever sank to this level, even the earth's atmosphere would freeze.

THE PLEIADES [Smithsonian Report 1916

A conspicuous cluster of bright stars in the sky. "The stars of any one group such as the Pleiades not only show the same physical properties but also have identical motions through space and thus journey perpetually through the sky in one another's society." (Jeans)

Speaking of the various heavenly bodies arranged in the order of their distances from the earth, Jeans says:

"Disregarding bodies much smaller than the earth, such as the moon, other planetary satellites and comets, we must give first place to the planets Venus and Mars, which approach to within 26 and 35 million miles of the earth respectively. Next in order comes Mercury with a closest approach of 47 million miles, and then the sun at about 93 million miles. Other planets follow in turn until we reach Neptune at a distance of 2,800 million miles.

"After this comes a great gap—the gap which divides the solar system from the rest of the universe. The first object on the far side of the gap is the faint star Proxima Centauri at a distance of no less than 25 million million miles, or more than 8,000 times the distance of Neptune. Close upon this come the two components of the binary star α Centauri at 25,300,000

million miles, these, with Proxima Centauri, form a triple system of stars which are not only near together in the sky, but are voyaging through space permanently in one another's company."

Again "The moon, our nearest neighbour in the sky, is 240,000 miles away from us, a distance which light, travelling at 186,000 miles a second, traverses in a little over one second. The farthest astronomical objects whose distance is known, are so remote that their light takes over one hundred million years to reach us. The ratio of these two periods of time—a hundred million years to a second—is the ratio of the greatest to the least distance with which the astronomer has to deal, and within this range of distances lie all the objects of his study."

We have said that we can see only about 3,000 stars with the naked eye, and you must have fairly good eyesight to see even that number. We have spoken about their sizes (p. 20) and their distances and their distribution in the sky (p. 30), and we have said that every star is in motion (p. 32). We have seen that there are double stars and triple stars, and, lastly, and in particular, we have described and spoken in detail about the sun and how it is constituted. The constitution of the other luminous stars is in the main the same as the sun.

[Photo: Mount Wilson Observatory

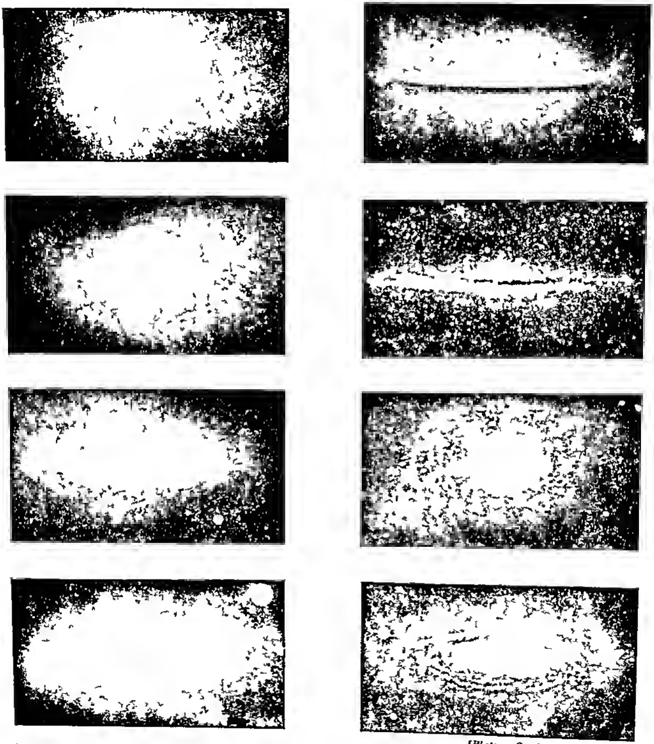
THE NETWORK NEBULAE IN CYGNUS

"These are completely irregular in shape. Their general appearance is that of huge glowing wisps of gas stretching from star to star, and in effect this is very much what they are. A cursory glance shows that each irregular nebula contains several stars enmeshed with it. The space between the stars is not utterly void of matter but is occupied by a thin cloud of gas of a tenuity which is generally almost beyond description." (Jeans in *The Universe Around Us*)

Types of Stars

Let us here consider some types of stars. The majority of stars, except for the twinklings caused by irregularities in our atmosphere, shine with a steady light. Their brightness, whenever it is measured, turns out to be the same. But this is not true for all the stars in the sky. There are

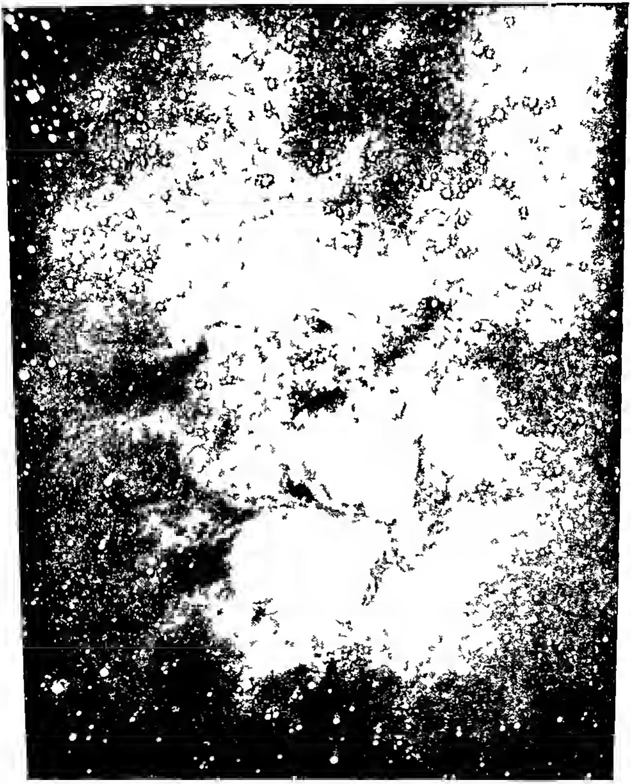
EVOLUTION OF NEBULÆ



[Photos: Smithsonian Report 1931

THIS PLATE SHOWS A SEQUENCE OF SHAPES INTO WHICH THE GREATER NUMBER OF NEBULÆ CAN BE ARRANGED

It begins with the globular fuzzy mass of gas having little or no rotation and ends with the flat cart wheel type, like our own Galactic System, which rotates much more rapidly. It is believed that this sequence represents stages in the evolution of the universe, that is to say, in the birth of stars. The last three illustrations in this series represent similar stages of evolution, being views taken at different angles.



[Photo Mount Wilson Observatory

THE THREE CLEFT NEBULA IN SAGITTARIUS

No doubt can be entertained that the genesis of the stars is a single process of evolution which has passed and is passing over a primordial distribution (Eddington)

They called them *planets*, or wanderers, and gave them names Their names are Mercury, Venus, Mars, Jupiter, and Saturn These bodies seem to wander about amongst the other stars in a somewhat irregular manner It is evident that our first simple idea of the celestial sphere is not adequate Something more complicated is required to explain fully the observed motions of the heavenly bodies

Copernicus Effects a Revolution

Such was the state of affairs when a Polish monk called Copernicus appeared and effected a revolution in astronomy He stated that the apparent daily motion of the sun and stars was due to the rotation of the earth The earth, he said, is spinning round like a top, and it completes one revolution every twenty four hours The sun and the stars are really fixed in space They appear to move only because we are viewing them from a rotating earth

And what of the planets? Copernicus stated that the planets really are moving But they are not revolving round the earth, they are revolving round the sun And Copernicus had the hardihood to add that the earth itself is a planet, making its revolution round the sun once a year And the moon? The moon is a body revolving round the earth—the only one of all the heavenly hosts that does so—and accompanying it in its journey round the sun

The Copernican theory came as a great shock to his contemporaries They were outraged at the undignified position accorded to the earth by this theory The earth, instead of being the centre of the universe, was merely one of a number of other planets circulating round the sun When the theory came to be examined, however, it was found to explain all the observed motions of the heavenly bodies so perfectly that there could be little doubt of its truth The theory was made still more perfect by the German astronomer Kepler

The next great step was made by Sir Isaac Newton, who succeeded in showing that all the observed planetary motions were due to the force of gravitation Newton stated that every body in the universe attracts every other body, and he gave the precise law according to which this force operates He showed how it depends on the masses of the bodies concerned and on their distances It is this force that maintains the planets in their orbits, that keeps the moon attached to the earth, and that causes a stone to fall to the ground

The Birth of Planets

It was not the Sun that gave birth to the solar system It gave birth to the planets, however The birth of our planets, it is believed, was due to tidal action, the tidal action set up on the sun by a passing star When two stars pass close to one another—that may mean millions of miles apart—the effect is for each to raise gaseous tides in the other, the closer they come to each other the higher the tides and glowing, swirling, gaseous material is drawn out in spiral arms from the stars These vast elongated arms, thick in the middle and tapering at each end, thus pulled away, and left behind, formed condensations or knots and broke up into planets, small planets at each end and big ones in the middle Thus was our earth born In their order of distance from the sun its planets are Mercury, Venus, Earth Mars, Jupiter, Saturn, Uranus, and Neptune, which is 2,800 million miles distant from the earth whereas the moon is only 238,000 miles away

Mercury and Venus

Between the earth and the sun lie the two planets, Mercury and Venus, of which Mercury is the nearer to the sun Observation has not been able to tell us much about either of them Mercury is small and is always fairly close to the sun, it is, therefore, difficult to observe It is doubtful whether Mercury has an atmosphere, but, in spite of that fact, it is not certain that any definite markings have been seen on its surface Even if Mercury has a slight atmosphere it must, owing to its nearness to the sun, be very hot, and it is very doubtful whether any life could exist on it

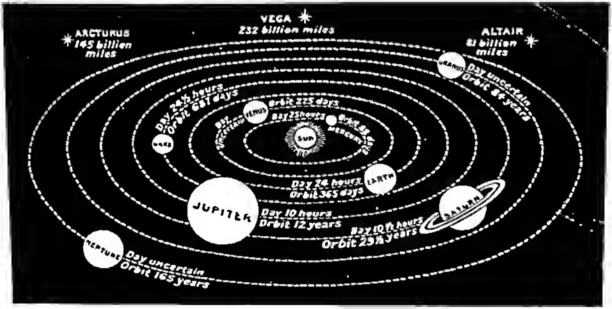
It seems perfectly possible, on the other hand, that life could exist on Venus, known to all as the morning and evening star, and the brightest of the planets. It is of nearly the same size as the earth. It is certainly a good deal nearer to the sun than we are, but the power of the sun's rays would be very largely shielded from whatever inhabitants there may be by the very thick atmosphere that envelops Venus. This same atmosphere, perpetually laden with heavy clouds, makes it impossible for us to see down on to the surface of the planet. There is some reason, however, to suppose that Venus is entirely surrounded by water, so that any life that exists on the planet has probably assumed fish-like forms

Does Life Exist on Mars ?

Passing outwards from the sun the next planet we come to is the Earth, which we shall describe in another chapter The first planet we reach, of those that lie beyond the earth, is Mars And, with this planet, the interesting question of habitability becomes acute. There is a certain amount of evidence to show that intelligent beings may exist on Mars This evidence is certainly not overwhelming, but it is equally certain that it cannot be dismissed in a line.

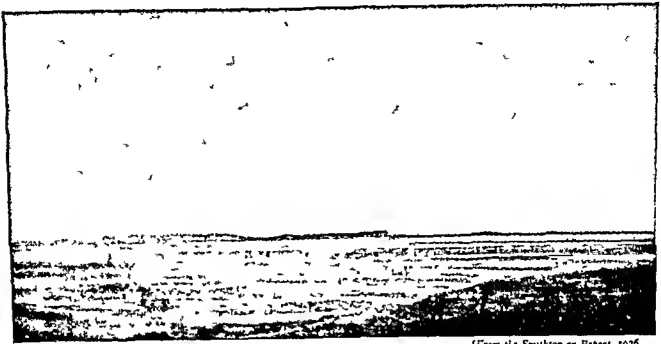
To begin with, the physical characteristics of Mars make it not impossible that it should support beings rather like ourselves. Mars is a smaller planet than the earth—indeed, its diameter is not much more than half that of the earth—and so its gravitational force would be less than that of the earth. Our bodies, on Mars, would seem unnecessarily bony and muscular. The difference, however, would not be prodigious

Further, Mars has an atmosphere. It is not as dense or as cloudy as our own, but it exists, and thin clouds float in it. Owing to the thinness of its atmosphere and to its greater distance from the sun, Mars would be colder than the earth—but perhaps not impossibly cold. Measurements of the heat radiated to us from various parts of the Martian surface seem to show that, even at the equator, the temperature falls below freezing-point at sunset. These measurements cannot yet be taken as definite,



A DIAGRAM OF THE SOLAR SYSTEM

It will be seen that the stars (outside the Solar System) in the diagram are at enormous distances showing the great isolation in space of the Solar System. The Sun s gravitational pull keeps the earth and the other planets revolving in circles round the Sun



[From the Smithsonian Report 1926

AN IMPRESSION OF THE MARTIAN EVENING

The probable character of a landscape upon the planet Mars seen in the dusk of evening. Its two small moons and the earth like an evening star, shine in its sky. Mars would be a bleak planet for any possible inhabitants owing to its thin atmosphere and great distance from the sun.

but they suffice to make it probable that Mars is distinctly cold.

So much for the general physical features of Mars. We now turn to its more particular characteristics. During the winter season on Mars both its north and south poles are seen to be covered with large white caps. Their appearance at once suggests that they are composed of snow. As the spring draws on these caps begin to disappear, until in the summer they almost vanish.

As the polar caps disappear the general surface of Mars undergoes a change. There are no oceans on Mars. The surface is composed of red desert and darker patches of ground. As the Martian spring advances these dark patches extend and deepen. This seasonal change occurs regularly at the same period of the Martian calendar, and on the same parts of the surface of the planet. These changes are, in fact, very much the same as the forest-clad earth would present if seen from a distant planet. It would not be rash to conclude that we have here evidence of the existence of vegetation on Mars. Another fact that helps out this conclusion is the fact that oxygen exists in the Martian atmosphere.

The Canals on Mars

We now come to consider the most remarkable and the most controversial of the Martian features. In the year 1877 Mars was in a particularly favourable position for observation, and an Italian astronomer, Schiaparelli, using a very perfect although not very large telescope, made the astounding discovery that the surface of Mars was covered with a network of fine dark, and geometrically straight lines. He called these lines "canali," or channels, a word carelessly translated into English as canals.

Since that time many other observers in various countries have reported that they also had seen the canals. Independent drawings of them made in various parts of the world show the canals as occupying the same identical positions. But there is no convincing evidence that they exist.

We shall quote the opinion of Jeans, in his own words: "The supposed canals on Mars disappear when looked at through a really large

telescope, and have not survived the test of being photographed Seasonal changes necessarily occur on Mars as on the earth, and certain phenomena accompany these which many astronomers are inclined to ascribe to the growth and decline of vegetation, although they may represent nothing more than rains watering the desert There is no definite evidence of life and certainly no evidence of conscious life, on Mars—or indeed anywhere else in the universe "

No Proof

It would seem that there is no conclusive proof of life on Mars But perhaps none of the objections to it are insuperable A defender of Lowell s theory, which maintains that there are intelligent 'Martians' on Mars could fairly say that there are probably local conditions on Mars of which we know nothing Also as Mars has probably been able to support life for a longer period than the earth it is possible that any intelligent beings that exist on Mars are further advanced than we are so that we need not be surprised if we are puzzled by some of their proceedings In any case Lowell s theory must be regarded as highly interesting and even fascinating But when all is said we have to admit that we have not yet any conclusive proof of the existence of intelligent life on any planet but our own

THE PLANET MARS

The two uppermost drawings showing the polar caps are by Professor Lowell and the bottom one by Professor Schiaparelli illustrates the famous canals

The first large planet we encounter on passing beyond Mars is Jupiter, but between the orbits of Mars and Jupiter lies a swarm of small bodies—the so called minor planets' The existence of these bodies was unsuspected until the beginning of the nineteenth century, when the first of them was discovered Since then about 2 000 have been found They are too small for any features of interest to be visible on them Indeed only three or four show measurable discs in the telescope The others look like mere points of light The biggest of them are only a few hundred miles in diameter, and many of the others are very much less They are of interest chiefly to mathematicians who find that their motions illustrate many fascinating problems

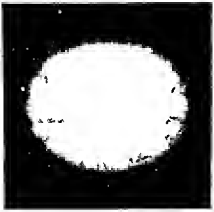
The theory has been put forward that these bodies are the result of the explosive disruption of a planet that used to circulate between the orbits of Mars and Jupiter but some mathematicians appear to have shown that this would not account for the observed distribution of these small bodies No certain conclusions can yet be drawn about their origin

Jupiter

Passing through the zone of the minor planets we come to Jupiter the mightiest of all the planets Jupiter is more than a thousand times as large as the earth by volume but its mass is not in proportion to its size for its density is only about one quarter of that of the earth This would seem to make it doubtful whether Jupiter even in the interior is solid Certainly the surface of Jupiter that

we see is not solid. Jupiter, as seen through a telescope, is covered strongly with marked horizontal belts of varying colours. From time to time these belts change, two becoming one, or one splitting up into two. In addition, there are bright and dark patches which change from month to month. None of the markings seen on Jupiter are permanent; they are doubtless masses of dense cloud.

It used to be thought that Jupiter was a dense mass of hot vapour, and it was regarded as doubtful, as we have said, whether it had any solid core at all. But in 1924 Dr. Harold



[Photo: Mount Wilson Observatory.

JUPITER

Showing the belts which are probably cloud formations.

Jeffreys, as the result of an argument based on *mathematical reasoning*, put forward an extraordinary picture of the physical state of Jupiter. He was led to believe that Jupiter consists of a rocky central core, surrounded by a layer of ice several thousand miles thick, which, in its turn, is surrounded by an extensive atmospheric layer. Thus Jupiter, instead of being hot, is regarded, on this view, as being exceedingly cold. There is much to be said for this theory, although it is not possible to say yet that it is fully confirmed.

Jupiter has nine known satellites; one of them is about the size of the moon, and two others are 50 per cent. greater in diameter.

Saturn

The next planet, Saturn, is considered by many observers to be the most beautiful object in the heavens. Certainly it is unique. The feature which makes it unique and which also makes it a beautiful telescopic object is the broad flat ring that girdles it at the equator. This great ring can, when Saturn is suitably placed, be seen even in a primitive telescope, but a good instrument is required to show its real structure. Close examination shows that the ring actually consists of three concentric rings. The outermost ring is nearly as bright as the body of the planet. The middle ring is also bright, and is separated from the outer one by a narrow dark space. The inner ring is much darker and is also semi-transparent, for the body of Saturn is

[Photo: E. F. Barnard, Yerkes Observatory.

SATURN

Showing the rings consisting of great swarms of meteorites.

visible through it. It has been appropriately named the ' crape ring.' The total breadth of the three rings is considerable; on the other hand, they are excessively thin. When Saturn is in such a position that the rings are presented to us edge on, they become invisible.

The actual nature of these rings was discovered from purely mathematical considerations, by James Clerk Maxwell. He showed that the rings could not be stationary solid arches embracing the planet. The toughest materials known would be altogether unable to support the immense gravitational pull of the body of the planet. If, in order to counteract this gravitational pull, we assume the rings to be rotating, then stresses will be set up in the rings which would tear them asunder. For the outer edge of a ring must rotate more rapidly than its inner edge, and this difference in velocity would be sufficient to dis

Book III

The Development of Religious Thought and Modern Discovery

CHAPTER I

[Photo Russell

SIR JAMES FRAZER

He is a leading authority on the evolution of religion He is the world famous author of *The Golden Bough* a monumental work which contains a great amount of information about any kind of ancient custom practice myth and legend He goes back to the ages when the world was young We know that the mistletoe is Virgil s Golden Bough that Rena carried it with him on his descent into the gloomy subterranean world and that it was an open sesame in his hands to unlock the gates of death Why the mistletoe was called the Golden Bough is the long complex story which Sir James Frazer set out to unravel and much more besides

IN this brief outline of the evolution of religious ideas, we must put a limit to the period in time to which we shall go back, if it is not to outrun the scope we have assigned to it For that reason we shall not discuss in detail the difficult question of the origin of religion To do so would mean an examination of conflicting theories, and the result would be fruitless Probably most of our readers are familiar with Sir James Frazer's views as set out in his great work, *The Golden Bough*, and with Professor A N Whitehead's valuable book, *Religion in the Making* For the beginnings of religion these two authorities would take us back beyond the dawn of history Not every one will accept Frazer's view of the origin of religion, those who disagree lean to the view that the history of religions shows that religion had its real origin not in the barbaric beliefs and practices of primitive man, but that men became ' religious " in a more advanced age, when they strained at the limits of their reach in knowledge, in things practical, emotional or intellectual On this view religion has not grown out of primitive forms of human consciousness, but has emerged as man attained a higher level As the mind of man developed so did a capacity for awe and reverence, higher intuitions possessed men's minds, demanding an emotional and intellectual outlet or expression

However, we need not stress any special theories or enter into any kind of analysis that seeks to explain religion in history from the earliest primitive savage tribes to what are called the ' founded ' religions among civilised peoples

EXCAVATORS AT WORK CLEARING GRAVES, UR (ABRAHAM'S CITY)

ASSESSING THE DAY'S FINDS FOR "BACKSHEESH," UR

Mr. Woolley says that excavators give these native workmen "backsheesh" as extra reward for objects they find. Apart from that, he says, many of the men take great pride in their job.

(Photographs on this page and on page 52 reproduced by courtesy of the Trustees of the British Museum and the Museum of the University of Pennsylvania.)

SOME OF OUR LEADING ARCHÆOLOGISTS

[Art Photo Service

SIR W FLINDERS PETRIE

[Photo Vaughan and Freeman

C LEONARD WOOLLEY

[Photo Elliott and Fry

PROFESSOR GARSTANG

[Photo Elliott and Fry

PROFESSOR R H SAYCE

[Photo Lafayette

SIR ARTHUR EVANS

[Photo Lafayette

DR LANGDON

During the present century many important discoveries have been made by British American and German archæologists in excavation work research and in digging up the past from long buried cities tombs and temples of ancient days We shall give in later pages of this work many examples drawn from many different fields, of the marvels of ancient civilisation as revealed by this exploration work

The doyen among these archæologists is Sir William Flinders Petrie, who has given fifty years of his life to excavation in Egypt and elsewhere He is a supreme authority on Egyptology Mr Leonard Woolley's name is mainly associated with the wonderful work he has done in Mesopotamia, especially at Ur in Chaldea The excavations at various sites besides that of Ur have provided truly surprising revelations They will be referred to later The excavation work of Professor Garstang and Professor R H Sayce also touches more or less directly on the Biblical narrative Dr Garstang's recent discoveries at Jericho generally bear out the Old Testament account of the fall of that city

Sir Arthur Evans made a great name for himself in connection with his excavations at Crete where he disclosed a great civilisation hitherto unknown whose importance from the point of view of world history can hardly be over estimated Dr Langdon is a great authority on Assyriology, and Professor in that subject at Oxford

We shall not concern ourselves with a formal study of comparative religions, nor with beliefs in particular doctrines, which are matters of personal belief, but with the broad question of religion in recorded history and its development to a place in modern thought, alongside scientific thought and philosophical thought As knowledge has grown so have men's religious beliefs passed from one phase to another. *And it is to the modern phase we wish to lead up* Unless we know the past we shall not understand the present This is specially true of the Christian religion

It is the peculiarity of religion, says Whitehead, that humanity is always shifting its attitude towards it Religion has been, he says, an unquestioned factor throughout the long stretch of human history He adds 'In considering religion, we should not be obsessed by the idea of its necessary goodness This is a dangerous delusion The point to notice is its transcendent importance, and the fact of this importance is abundantly made evident by the appeal to history"

Frazer on Origins

Although we have said it is not our purpose to go into the question of origins, nevertheless some preliminary observations are necessary We shall do that by briefly summarising Sir James Frazer in the following paragraphs In our search for origins it is necessary to push our inquiries far back into the past

"The ancients themselves inherited a great part of their religion from their prehistoric ancestors, and accordingly it becomes desirable to investigate the religious notions of these remote forefathers of mankind, since in them we may hope to arrive at the ultimate source, the historical origin, of the whole long development"

It is not possible now to get first hand knowledge of the beliefs and practices of prehistoric peoples directly, we have to resort to comparative methods of research and, as it were, contemplate in a mirror the reflections of the originals

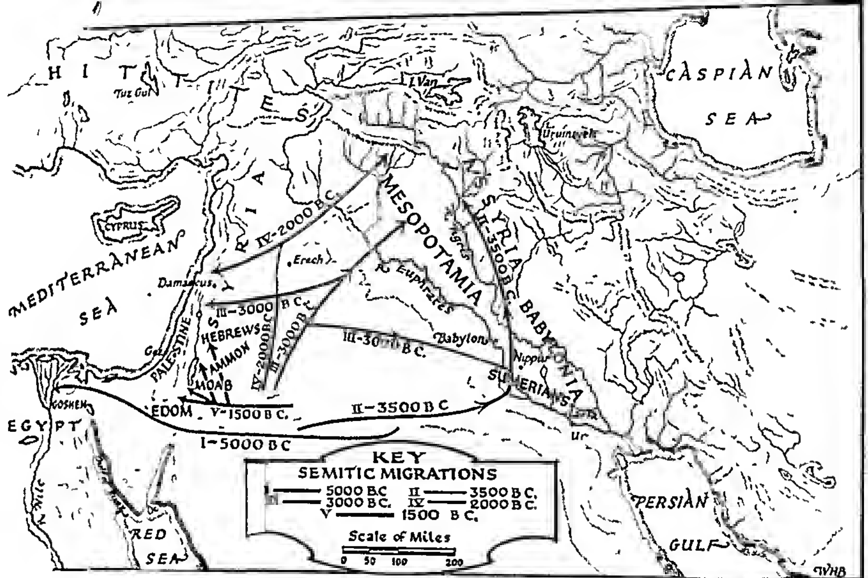
'A study of the savage and barbarous races of mankind is of the greatest importance for a full understanding of the beliefs and practices—whether religious, social, moral, or political—of the most civilised races, including our own since it is practically certain that a large part of these beliefs and practices originated with our savage ancestors, and has been inherited by us from them, with more or less of modification, through a long line of intermediate generations

"If we are trying to trace historically man's conception of God to its origin, it is essential that we should begin by studying the most primitive ideas on the subject, and the most primitive ideas are unquestionably those of the lowest savages

"If we civilised men insist on limiting the name of God to that particular conception of the divine nature which we ourselves have formed, then we must confess that the savage has no god at all But we shall adhere more closely to the facts of history if we allow most of the higher savages at least to possess a rudimentary notion of certain supernatural beings who may fittingly be called gods, though not in the full sense in which we use the word That rudimentary notion represents in all probability the germ out of which the civilised peoples have gradually evolved their own high conceptions of deity, and if we could trace the whole course of religious development, we might find that the chain which links our idea of the Godhead with that of the savage is one and unbroken" That, at any rate, is Frazer's opinion

Sir James reminds us that we have no more reached a stage of finality in our religious beliefs or ideas about a deity, than science has reached a stage where she has no more problems to solve Science has only touched the fringe of what she may yet know, within reasonable time she will doubtless add great things to her past achievements But beyond that there will still be problems enough And beyond that again, problems that will for ever remain mysteries, so long as man's mind has to work within its imposed limits

"The history of thought should warn us against concluding that because the scientific theory of the world is the best that has yet been formulated, it is necessarily complete and final We must



[After Dr. Abram Leon Sachar, author of "A History of the Jews"

EARLY SEMITIC MIGRATIONS LEADING TO THE COMING OF THE HEBREWS

The story of the coming of the Hebrews into history is told in the text (see page 53 *et seq.*). They sprang from the historic Semites, nomadic tribes whose wanderings in the Arabian desert have been traced back as far as 5,000 B.C. The earliest known migration (I) was to the Nile. Later in 3,500 B.C. other Semitic groups (II and III) explored the fertile valleys of the Tigris and the Euphrates. They conquered the settled and civilised Sumerians and adopted many of their arts and ways of living. A map of the Land of the Hebrews will be found on page 62.

To face page 49]

remember that at bottom the generalisations of science or, in common parlance, the laws of nature are merely hypotheses devised to explain that ever-shifting phantasmagoria of thought which we dignify with the high sounding names of the world and the universe In the last analysis, magic, religion, and science are nothing but theories of thought, and as science has supplanted its predecessors, so it may hereafter be itself superseded by some more perfect hypothesis, perhaps by some totally different way of looking at the phenomena—of registering the shadows on the screen—of which we in this generation can form no idea"

Whitehead's Ideas

Professor Whitehead, who is one of our most eminent scientists and philosophers, speaks in similar words on each of the points mentioned The dawn of religious strivings is seen in the early savage tribes and a progressive religious consciousness slowly emerges on higher levels Professor Whitehead says

"Religion, so far as it receives external expression in human history, exhibits four factors or sides of itself These factors are ritual, emotion, belief, rationalisation There is definite organised procedure, which is ritual, there are definite types of emotional expression, there are definitely expressed beliefs, and there is the adjustment of these beliefs into a system internally coherent and coherent with other beliefs The order of the emergence of these factors was in the *inverse* order of the depth of their religious importance first ritual, then emotion, then belief then rationalisation The dawn of these religious stages is gradual It consists in an increase of emphasis Perhaps it is untrue to affirm that the later factors are ever wholly absent But certainly, when we go far enough back, belief and rationalisation are completely negligible, and emotion is merely a secondary result of ritual Then emotion takes the lead, and the ritual is for the emotion which it generates Belief then makes its appearance as explanatory of the complex of ritual and emotion, and in this appearance of belief we may discern the germ of rationalisation"

The whole society of the savage tribe was knit together and consolidated by primitive collective ritual, expressing their beliefs and their emotions

"Ritual is more impressive and emotion more active when a whole society is concerned in the same ritual and the same emotion Accordingly, a collective ritual and a collective emotion take their places as one of the binding forces of savage tribes

"Rituals and emotions and myths interact, and the myths have various grades of relationship to actual fact, and have various grades of symbolic truth as being representative of large ideas only to be apprehended in some parable Also in some cases the myth precedes the ritual But there is the general fact that ritualism precedes mythology

"In a sense the ritual is the primitive worship of the hero person, or the hero thing But there can be very little disinterested worship among primitive folk The belief in the myth will involve the belief that something is to be got out of him or it, or that something is to be averted in respect to the evil to be feared from him or it"

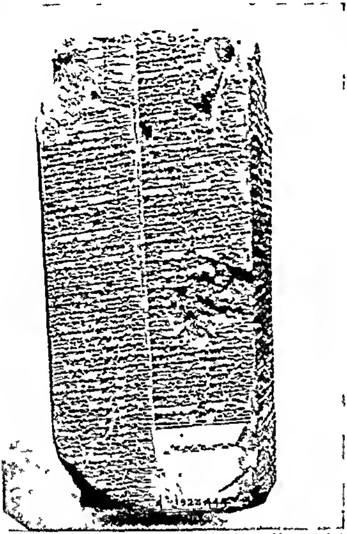
We shall see how true all this is in the case of the development of the ancient Hebrew religion, and also that of the Greeks

Evolutionary Emergence

A rational religion emerges with the progress of mankind, and again in its collective expression binds a people together

'The emergence of rational religion was strictly conditioned by the general progress of the races in which it arose It had to wait for the development in human consciousness of the relevant general ideas and of the relevant ethical intuitions It required that such ideas should not merely be casually entertained by isolated individuals, but that they should be stabilised in recognisable forms of expression, so as to be recalled and communicated You can only speak of mercy among a people who, in some respects, are already merciful'

Professor Whitehead's last note is similar to that of Sir James Frazer—a warning against



[By courtesy of the Ashmolean Museum Oxford

This fine cuneiform prism of baked clay mentions the Ten Patriarchs who lived before the Flood

outside our scope to summarise those chapters in Frazer's monumental work *The Golden Bough* which, with great elaboration, picture primitive customs and beliefs, myths and rituals, and the practices of men when the social world was in its infancy. As he remarks, a study of these primitive customs and beliefs supplies the same sort of evidence of the evolution of the human mind that an examination of the embryo supplies of the evolution of the human body.

All we propose here is to confine ourselves, for the most part, and that broadly, to the evolution of three religions, the Hebrew, the Greek, and the Christian, the last of which sprang from the other two. Or, rather, it would be truer to say that the Christian religion sprang from the Hebrew, and when it came to be rationalised as a theology it was largely formulated in terms of Greek philosophy, and appropriated many of the ceremonial customs and practices of the pagan "mystery religions."

looking for finality in our present stage of evolutionary thought.

"Religions commit suicide when they find their inspirations in their dogmas. The inspiration of religion lies in the history of religion. By this I mean that it is to be found in the primary expressions of the intuitions of the finest types of religious lives. The sources of religious beliefs are always growing, though some supreme expressions may lie in the past. Records of these sources are not formulæ. They elicit in us intuitive response which pierces beyond dogma."

We have selected Sir James Frazer and Professor Whitehead as two representative authorities on the evolution of religious beliefs. It is

§ 1

Biblical Criticism

Without further preliminary remarks we come, then, to the subject of this section, which deals with some results of modern discoveries and historical research—or, in other words, historical Biblical criticism. The present century has been just as busy here as it has in the region of science, and if we are to follow the tendency of present day religious thought we must understand something of the nature of the historical research and criticism that have given rise to the reconstruction of religious belief, and to what is called "Modernism." As we have said, in this study the evidence of the evolution of human beliefs is analogous to the evolution of man himself.

However it may have been in years gone by, no intelligent person to day believes that the Biblical account of Hebrew origins is too sacred to question, or that the Old Testament itself is

too sanctified by the devotion of ages to be the object of historical and scientific research and criticism No criticism affects in the slightest its value and importance as a record of a people's spiritual progress It is a great human document, "a tribute to the versatility and candour of Hebrew genius" The Bible is one of those things about which most people are not well informed Indeed, Hebrew history as narrated in the Old Testament books is very confused and difficult to piece together, for a reason that we shall refer to later

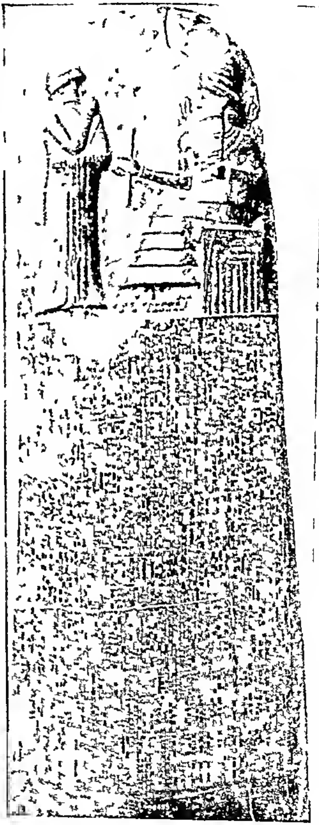
We may remark also that the paganism of *ancient Greece, with which we shall deal in* due course, and the mystery religions of Greece, are regarded now from quite a different standpoint than they used to be As Dr Inge says, without what we call our debt to Greece we should have neither our religion nor our philosophy

§ 2

The Hebrew Nation

THE Hebrew religion is the obvious one for us to take first Israel has been a world influence The history of Israel in one paramount aspect has an interest surpassing that of any other nation of antiquity And it is quite different Israel was but a small nation compared with the great empires of antiquity In power in martial glory, in commerce, in education in art she was far behind But the greatness of Hebrew literature has to be acknowledged We may quote here an illustrative passage from a German writer, Bernhard Stade, in *The Historians History of the World* It emphasises the point

' And if as we see, Israel is far surpassed in martial glory by the peoples of the great empires, and by the Romans in their influence on the development of law, there are yet other points in which it must yield unquestioned precedence to other nations of antiquity We do not find in Israel the same feeling for beauty as among the Greeks, who, like no nation before them or after showed forth the laws of beauty in every sphere of intellectual life and to this day in such matters stand forth in a perfection which has never again been attained, far less excelled



[*Mansell*

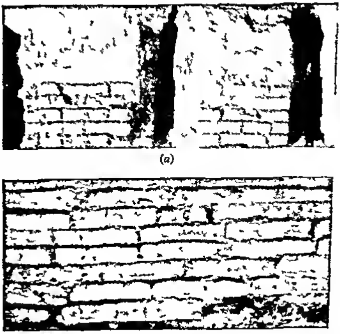
Archaic Babylonian Text of Hammurabi s Code of Laws Hammurabi founded the first Babylonian Empire He is seen here receiving the Laws from the Sun god (See page 55)

Among the Hebrews there is nothing analogous, nothing comparable to what we admire in the Hellenic people. It has no epic, nothing that can be compared with the *Iliad* and the *Odyssey*, against which the Germans set the *Nibelungen Lied* and the Finns the *Kalevala*; it has not the slightest rudiments of a drama—the Song of Songs and Job are not dramas. There is a school of lyrical poetry unsurpassed for all time, and the music that corresponds to it. But the bent towards science, which actuates the Greeks, is wholly lacking—wholly lacking the bent towards philosophy. Nor was it ever eminent in ancient days in the walks of commerce, enterprise, and invention, by which also a nation may conquer the world: its intellectual life is absolutely one-sided, a one-sidedness that produces on us the effect of extreme singularity.

"But the attraction it has for us does not lie in this singularity. It is due, rather, to the circumstances that this small nation has exerted a far greater influence over the course of the history of the whole human race than the Greeks or Romans, that to us it has become typical in many more respects than they.

"What Israel did in the sphere of religion is without a doubt far more epoch-making, unique, and effective than what the Romans did in the sphere of politics, or the Greeks in that of art or science. As Israel assumed the leadership of the human race in religion, so Rome did in matters of government, and Greece in questions of philosophy; but while the civilised nations which adopted Roman law strove with increasing energy to free themselves from the band of Roman legal conceptions, while the relics of Greek art and science only roused the enthusiasm of a chosen few, and the philosophy which the Greeks had created was confined within ever-narrowing limits by religion on the one hand and the ever-widening field of science on the other; religion embraces all classes of the people from the king to the beggar, and strives more and more to embrace all the nations upon earth. Moreover, however men may shut their eyes to the fact, among ourselves to-day religion is a subject of far more universal interest than art, science, or any political institution whatsoever. Disputed questions of religion shake kingdoms and kindle the most sanguinary wars. By this means it changes the character of nations and brings forth new national types.

"Thus the importance of Israel in the history of mankind and, consequently, our interest in its own history, is due to the leading part it took in the sphere of religion. In Israel, indeed, religion—or, as most people prefer to express it, monotheism—first came into being. Let not the reader misunderstand the latter word. The monotheism of Israel is not the acknowledgement that there is but one Supreme Being. That is not a religious but a philosophical idea. The God of the Israel of old is not to be defined as the sole, supreme, and absolutely perfect being, but as the Not-World, or, better still, as the sum of all forces present and active in the world conceived of apart from the substratum through which they are manifest in phenomena. Hence



(a)

(b)

Temple walls at Ur with royal inscriptions on the bricks giving evidence of date (a) of Bur Sin 2200 B C, (b) of Kurigalzu 1400 B C

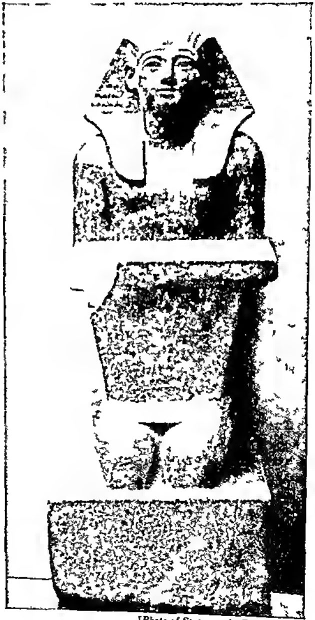
[Photo of Statue in the Cairo Museum

THOTMES III
The Pharaoh of the Oppression

the God of Israel of old is simply the Mighty One But in the eyes of the Israelite of old the world was no wider than the land that nourished him For this reason the God of ancient Israel is the God of the Land of Israel and the actual existence of the gods of other nations is not denied They exercise in the lands of other nations the same sway as Israel's God in the world of Israel'

The Historical Background

In the study of the evolution of these two religions the Hebrew and the Christian it is important to have the historical background before us a clear picture of the people who dominated the land of Mesopotamia 3000 years B C That was about 1500 years *before* the date we hear of the Hebrews for the first time We shall see by and by how important that is for a proper understanding of the Old Testament writings, and the ideas put forward by the writers of the books which ultimately became the Old Testament In particular we have to turn to the Babylonian and Assyrian empires, for no student can expect to have an intelligent understanding without some knowledge of the history of the people that preceded the Hebrew nation It is not necessary to sketch at any length the history of these predecessors of the Hebrews, we only need sufficient to illustrate the source of many of the religious ideas of the ancient Hebrew writers



[Photo of Statue in the Cairo Museum

AMENHETEP II
The Pharaoh of the Exodus

We need but mention the oldest civilisation of all in that part of the world, the Sumerian civilisation The Sumerians came of an unknown language and race Before 3000 B C they had settlements in the region of the Euphrates and the Tigris, and their culture was of a high order They faced a hostile race, the Semitic nomads *of the desert*, by whom they were conquered about 2750 B C, and with whom they later comingled The Semitic leader was Sargon, who had united the Semitic tribes, the later Hebrews and Arabs were descendants of two of these tribes

About the year 3000 B C, then, (1500 years before we hear of the Hebrews), the Semitic nomads of Arabia were drifting in from the desert and settling in the region of the Euphrates and Tigris

[*By courtesy of the Metropolitan Museum of Art, New York*

QUEEN HATSHEPSUT

This is a photograph of the head of the statue of Queen Hatshepsut She is supposed to be identified as the patroness of Moses As legend has it she saved Moses from the waters of the Nile

Professor Breasted in his fine history *Ancient Times A History of the Early World* has pictured the influences at work in the formation of their religion as follows

"The wilderness is the nomad's home Its vast solitudes have tinged his soul with solemnity His imagination peoples the far reaches of the desert with invisible and uncanny creatures, who inhabit every rock and tree, hill top and spring These creatures are his gods, whom he believes he can control by the utterance of magic charms—*the earliest prayers* He believes that such charms render these uncanny gods powerless to do him injury and compel them to grant him aid

"The nomad pictures each of these beings as controlling only a little corner of the great world, *perhaps only* a well and its surrounding pastures At the next well, only a day's march away, there *is another* god, *belonging to the* next tribe For each tribe have a favourite or tribal god, who, as they believe, journeys with them from pasture *to* pasture, sharing their food and their feasts and in addition receiving as his due from the tribesmen the firstborn *of their flocks* and herds

"The thoughts of the desert wanderer about the character of such a god are crude and barbarous, and his religious customs are often savage, even leading him to sacrifice his children to appease the angry god On the other hand the nomad has a dawning sense of justice and of right, and he feels some obligations of kindness to his fellows which he believes are the compelling voice of his god Such feelings at last became lofty moral vision which made the Semites the religious teachers of the civilised world"

THE ARRIVAL OF A TRIBE OF SEMITIC NOMADS IN EGYPT ABOUT THE YEAR 1895 B C
Ancient Egyptian wall painting in a tomb near Beni Hassan Middle Egypt

Ancient Civilisation

The first Babylonian empire was founded under a great king Hammurabi about 2100 B C He had become master of all Mesopotamia Higher up the Tigris another race the Assyrians were settling about a number of cities among which were Assur (which gives its name to the land of Assyria) and Nineveh

It was about this time Abraham was born at Ur in Sumeria at the very southern end of Babylonia

What was the civilisation of the ancient world of Mesopotamia like in those days—in the age of the great king of Babylon Hammurabi who as we have said founded the first Babylonian Empire and was flourishing about the year 2100 B C ?

Hammurabi brought order and system into civic and national life such as Babylonia had never seen before Thanks to the discovery of a collection of clay tablet letters and a great many documents which have survived over four thousand years including Hammurabi s Code of Laws we have a considerable body of information

We quote from Breasted s *Ancient Times*

With his eye thus upon every corner of the land alert vigorous and full of decision the great king finally saw how necessary it was to bring into uniformity all the various and sometimes conflicting laws and business customs of the land *He therefore collected all the older* written laws and usages of business and social life and arranged them systematically He improved them or added new laws where his own judgment deemed wise and he then combined them into a great code or *body of laws* It was writteo not in *Sumerian as some of the* old laws were but in the Semitic speech of the Akkadians and Amorites He then had it engraved upon a splendid shaft of stone At the top was a sculptured scene in which the king was shown receiving the law from the Sun god The new code was then set up in the temple of the great god Marduk in Babylon This shaft has survived to our day the oldest preserved code

of ancient law Fragments of other copies on clay tablets, the copies used by the local courts, have also been found "

The Overlord

We note the words "*receiving the law from the Sun god*," and in that connection we quote the following few lines from Mr H G Wells's *Outline of History*

"The god of the priests remained as the real overlord of the land and of priest and king alike He was the universal landlord, the wealth and authority of his temples and establishments outshone those of the king Especially was this the case within the city walls Hammurabi, the founder of the first Babylonian empire, is one of the earlier monarchs whom we find taking a firm grip upon the affairs of the community He does it with the utmost politeness to the gods In an inscription recording his irrigation work in Sumeria and Akkadia, he begins 'When Anu and Bel entrusted me with the rule of Sumer and Akkad ' We possess a code of laws made by this same Hammurabi—it is the earliest known code of law—and at the head of this code we see the figure of Hammurabi receiving the law from its nominal promulgator, the god Shamash" The reader should bear these words in mind when we come to speak of Moses

Right through the history of the Babylonian and Assyrian empires, says Mr Wells, "no monarch seems to have felt his tenure of power secure in Babylon until he had 'taken the hand of Bel'—that is to say, that he had been adopted by the priesthood of Bel as the god's son and representative"

It was "an act of political importance in the conquest of any city to carry off its god to become a subordinate in the temple of its conqueror This was far more important than the subjugation of king by king" Sometimes a conqueror was afraid of the god he had conquered ' In the Bible is related (Sam I, v, 1) how the Ark of the Covenant of the God of the Hebrews was carried off by the Philistines, as a token of conquest, into the temple of the fish god, Dagon, at Ashdod, and how Dagon fell down and was broken, and how the people of Ashdod were smitten with disease"

§ 3

History of the Early Hebrews

FIRST of all, let us confine ourselves to the secular and political history of the Hebrew race, as fascinating a history as is to be found anywhere We shall see how intimately Hebrew religion is bound up with it

Let us go back to the date of about 1500 or 1400 B C It is about that date we begin to hear of the Hebrews for the first time They were originally men of the Arabian deserts We have seen something of the history of the Babylonian-Assyrian empire, and we shall see how many of the Babylonian and Assyrian myths and religious beliefs were, at a later time, taken over by the Hebrew writers

These are the people with whom we are concerned here, the people to whom we owe the Old Testament, the people who displayed such religious genius We fix our eyes on the date, about fifteen hundred years before the dawn of the Christian era The land is the Land of Canaan, which we now know as Palestine The Hebrews were all originally men of the Arabian desert, and we have to picture them wandering with their flocks and herds, slowly drifting over into Palestine For about two centuries (about 1400 to 1200 B C) this movement goes on Many centuries before that date the patriarch Abraham had lived in the city of Ur, in Chaldea

It will be convenient if at this point we take up the story of the Hebrews as it is told in the Books of the Old Testament, disconnectedly, over lapping, and in repetition—difficult to piece together

Discoveries about Abraham

In the light of knowledge that we have now it seems reasonably certain that Abraham was born in Ur about 2000 B C, although we are not given in the Book of Genesis any precise data to determine the age in which he lived, the conditions of his time, and the state of the land in which he lived For such information we have to rely on modern research We are merely told in Genesis that 'the Lord said unto Abram, Get thee out of thy country

"JACOB S LADDER"

(Photos by Mr C L Woolley, Director of the Joint Expedition of the British Museum and the University Museum Philadelphia, to Mesopotamia)

JACOB S LADDER?

Mr C Leonard Woolley writes The Ziggurat of Babylon has been made famous to us by the Bible story of the Tower of Babel and the confusion of tongues, and it was only one of many for every great city of ancient Babylonia possessed a similar staged tower and to day the ruins of these are the most conspicuous features of the flat Euphrates valley

The Ziggurat at Ur shown in these two illustrations was a tower built in stages giving the effect of a stepped pyramid leading to a little shrine at the top dedicated to the patron god, the Moon God

Of the top illustration Mr Woolley writes 'Was this at the back of Jacob s Dream of the ladder going up into Heaven? (Arab labourers are seen descending the stairways)

The lower illustration shows the steps to the Throne of God' Three stairways lead up to the summit of the Ziggurat The House of the Mountain of Heaven' was built 300 years before Abraham dwelt at Ur

and from thy kindred, unto a land that I will show thee" That land was Canaan

Much study and research have been given to the origin and historical emergence of the books of the Old Testament by many investigators well qualified by specialised training in research and in Biblical criticism Excavations and exploring expeditions have been busy and have laid bare many very interesting facts, and supplied something of a real background

At Ur, for example, the City of Abraham, much new knowledge has come to light within the last few years While, doubtless, there is much that is purely mythical about patriarchs like Abraham and Moses, their historical character is becoming clearer, certainly they, or some such persons, are not altogether mythical Probably they were not even the roaming Bedouin chiefs leading a sort of barbaric people such as some have supposed Mr C Leonard Woolley, whose experience in exploration and excavation work is very wide, believes that altogether the life of such a man as Abraham, at Ur, in the twentieth century B C was the sophisticated life of a citizen The elaborate conditions of domestic and national life of the period, it is now found, were astonishing and must affect our conception of the patriarch Abraham, for example The pre historic tombs at Ur, fifteen hundred years *older than even Abraham*, have provided revelations that are truly surprising We must make allow ances, Mr Woolley says, for antecedents very different from those of the Bedouin tent-dwellers "From the beginning Hebrew customs and beliefs were coloured and informed by the traditions of a very old and very artificial non Semitic civilisation" The excavations at many points touch more or less directly on the Biblical narrative Sometimes, indeed, "instead of the excavations throwing light on the Bible, the Bible has to be called in to explain the facts of excavation" It is not impossible that "by the accident of survival and the chances of discovery" further excava tion work will produce direct evidence of Abraham's life at Ur of the Chaldees

The Book of Genesis gives no kind of consecutive biography of Abraham It merely gives a few selected extant traditions of the patriarch's life current among the Hebrews The narratives are such as best illustrate the supposed origin of the Hebrew nation We do not know what moved Abraham to quit Ur of the Chaldees, but it seems clear that he, or some other, did head a great movement of the Hebrews from Mesopotamia into Canaan

Mythical Origins

To keep our story clear we shall neglect the theory of some writers who believe that the patriarchs really stand merely for tribal deities of folklore, or reflect the composite lives of semi-divine heroes, and that men like Abraham were not actual individual personages That is a theory which has no actual foundation, any more than as yet there can be established the existence of a veritable man Abraham Even if the Hebrews invented a mythical story to account for the origin of their race they did no more than the Greeks and the Romans did

Taking the Biblical account, we have to picture an Abraham to whom God promised the fair land of Canaan, and to his kindred, and to make of him a great nation He journeyed forth toward the south, but driven by a grievous famine he went to Egypt and sojourned there The princes of Egypt bring the report of the beauty of Abraham's wife to Pharaoh, King of Egypt, who has her placed in his own harem In cowardly fear of his own life," as Bishop Ryle puts it, 'Abraham says that Sarai is his sister and does not acknowledge her as his wife In great dudgeon Pharaoh summons Abraham, justly reproaches him for the deception, and dismisses him and his belongings from Egypt" We need not follow the subsequent narrative, derived from various sources, many difficulties and discrepancies strike the careful reader There are pictured, too, the lives of Isaac and Jacob—Jacob whose name was changed to Israel

§ 4
Moses

HISTORIANS say there may have been a little group of Hebrews settled in Egypt

[Mansell

STATUE OF GUDEA WHO WAS ONE OF THE GREAT RULERS IN SUMERIAN HISTORY (ABOUT 2400 B C)

Showing a very early inscription Sumerian style

The Sumerians existed long before the days of Assyria and Babylonia They came of an unknown language and race Perhaps they were the earliest people to found cit es ' They developed their civilisation through a period that may be as long as the whole period from the days of Moses to the present time ' ' At Nippur they built a great tower of brick to their chief god El lil, the memory of which is supposed to be preserved in the scriptural story of the Tower of Babel '

[After the painting by Rembrandt van Ryn

MOSES BREAKING THE TABLES OF THE LAW

cultural people And it is characteristic of the growing religion that, though his seat was still for centuries to be regarded as being on Sinai, it was held that his ' presence ' could follow the people through the desert in the sacred Ark which was plainly a device for carrying the *mana* of the desert into the land of the Canaanites Perhaps there was a piece of Sinaitic rock in the Ark—we do not know , but we know that even after the promised land was reached his presence still remained somehow in the Ark which now became Israel s central shrine The forward step was significant As time went on Yahweh became more and more the God of Israel less and less the God of the Sinaitic desert , and thus he gradually came to be identified with Israel s new land and to be regarded as the source of its fertility and the guardian of its borders "

At any rate, fortified by many signs and wonders and promises of Yahweh's help, Moses went about his task He set about the task of leading the children of Israel into the land promised to Abraham and his seed After long delay, when the reluctant Pharaoh was coerced by the plagues showered on Egypt, Moses and his people were allowed to depart , they escaped to the Red Sea The pursuing Egyptians were drowned, and the miraculous preservation of the chosen people at the critical moment marks *the first stage* in the national history

The Exodus Drama

The long narration is in the Book of Exodus The number who set out from Egypt was " about six hundred thousand on foot that were men, besides children, and a mixed multitude went up also with them , flocks and herds, even very much cattle "

We shall not attempt any picture of the events of the *forty years* in the wilderness—the drama of the migration of Moses and his trying wife and son , Aaron, priest and colleague , and the crowd of squabbling tribes traversing the desert in trial, disappointment, and rebellion, to the goal of the promised land This was a slow tribal migration—forty years At times we have to picture the Israelites leading a more or less settled life in the country on the south of Palestine, and perhaps flourishing agriculturists But already a number of Hebrew clans had joined together to fight a common adversary , we pass over that

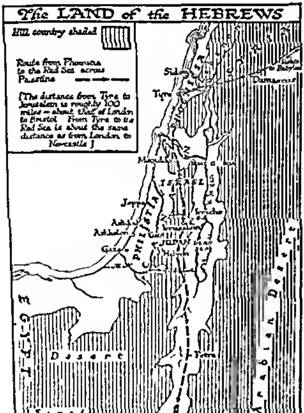
Moses the masterful leader and lawgiver, a supreme personality, whom many modern critics believe to be a definite historical character, died before he set foot in the promised land, the land of Canaan , he died on Mount Nebo, over against Jericho, and ' no man knows his sepulchre " He was an hundred and twenty years old when he died ' His eye was not dim, nor his natural force abated " At Mount Sinai

he had delivered to his people the tables of the Ten Commandments, and promulgated the laws and statutes that were to govern their lives

We do not know how much of the story of Moses is legendary The result of Professor Garstang's Palestine expedition and excavations (1932) seems to confirm the exodus out of Egypt at a date in the reign of Pharaoh Amenophis II (1447–1420 B C)

Joshua

Meanwhile Joshua is appointed to succeed Moses, and he prepares to pass over the Jordan , the waters were miraculously parted and all the people passed over Joshua and his rude army —we have still the picture of a migrating people—now come up against the Canaanites, a civilised people dwelling in flourishing towns protected by high walls , it was a civilisation already fifteen hundred years old, with comfortable houses, government, trade, writing, and religion The Israelites compass and besiege Jericho, and we are given a list of the lands conquered and the land not yet conquered



Professor Garstang's recent discoveries at Jericho generally bear out the Old Testament account of the fall of that city According to his excavations and study of the geological strata, in addition to archæological work on the walls of Jericho, there is revealed " undoubted evidence that the collapse of the walls was caused by an earthquake," and that the city was stormed by invaders, and shows " impressive traces of deliberate burning " (See confirmation Psalm 114, which is undoubtedly the story of an earthquake *) " Excavations inside the ruins proved that although the city was burnt it was not plundered For amongst the debris of the houses, and in what was once the store rooms of the palace itself, were found the remains of wheat, dates, barley, and other foodstuffs, reduced to charcoal by the terrific heat, and so preserved to tell their story 3000 years later This affords a minute confirmation of the Joshua narrative "

The rude Hebrew people were soon adopting Canaanite civilisation and mingling with the Canaanites This produced the most profound changes in the life of the Hebrews They left their tents and began to build houses In a word, " after a time, in appearance, occupation, and manner of life the Hebrews were not to be distinguished from the Canaanites among whom they lived "

When the Hebrews first entered Palestine they knew little of the ways of settled communities

* Professor Garstang in a letter to the *Times* writes " With the Biblical date approximately 1400 B C , as basis the outline of the subsequent history of Israel in Canaan as narrated in the Books of Joshua and Judges seems to me after ten years of local investigation in the course of which I have personally examined every site and route involved to be free from any radical archæological or topographical objection On the other hand, the later dates advanced by modern theorists lead at once into archæological difficulties besides involving distortion of the narrative itself The *onus probandi* surely now rests with those who reject the Biblical tradition

TABLE OF HEBREW DATES

TIME OF ABRAHAM	2000 BC
MOSES AND THE EXODUS	1250 BC
FROM MOSES TO SAUL (first King)	say 250 years
DAVID AND SOLOMON Reign	1010-933 BC
UNITED HEBREW KINGDOM split into two	930 BC
FALL OF ISRAEL KINGDOM	721 BC
FALL OF JUDAH KINGDOM	597 BC
FALL OF JERUSALEM AND HEBREWS EXILED *The Exile lasted about 50 years during which the "Priestly Code" was formed*	586 BC
JERUSALEM RESTORED FOUNDATION OF THE JEWISH SYNAGOGUE A HEREDITARY HIGH PRIEST BECOMES RULER OF THE JEWS	458 BC
THE MACCABEAN REBELLION	415-167 BC
FALL OF JERUSALEM AND DISPERSION OF THE JEWS	70 AD

'They were, even in the idealised Biblical accounts, a disunited, untutored folk, amazed even by the primitive civilisation of the Canaanites Fate orders its miracles capriciously From such crude and unpretentious beginnings there were to develop sages and saints and prophets who consecrated the soil on which they preached, a religion of tremendous power, from whose body sprang two others of enduring force and vitality, and a literature of rare, spiritual quality, the autobiography of a God-intoxicated people

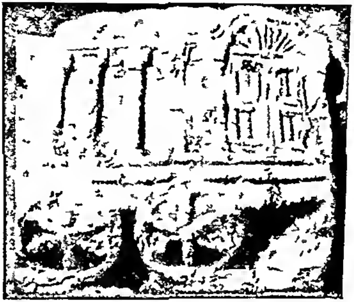
'The entrance of the Hebrew tribes into Canaan completely changed their destiny Their outlook had been nomadic, their habits and customs largely bedouin They now became settlers on a fixed soil, acquired homes, took pride in personal possession Everything in the civilisation of the land astonished their half open minds, the little towns and hamlets, walled and protected with fortresses, the fields and their abundant products, the weapons of war, especially the devastating, swiftly moving chariots, the implements and utensils of peace They watched and imitated They learned how to till the soil, to make garments, and to manufacture tools They began to produce corn, wine, oil, and figs and to exchange their surplus for the products of Tyre and Sidon With new means of sustenance their population increased materially They began to think of the future and to wonder about the past They learned the alphabet and though at first, perhaps, it served merely for a charm on a weapon or a name on a stone, it was soon employed to record the lusty songs and the extra ordinary deeds of legendary heroes" (Sachar)

The Philistines

The Hebrews under the resolute Joshua pursued their slow subjugation of the land, then they came up against the Philistines We must understand that the Hebrews were often hemmed in on every side by other tribes Peaceful relations alternated with fresh wars and struggles The Philistines themselves were newcomers who had settled along the coast in a number of cities At any rate, the Hebrew invaders had now to reckon with the Philistines They began a long and not very successful struggle The high spirited Joshua had experienced his first triumphs, but

they are short lived Indeed we read in Judges I and II of a melancholy catalogue of failures His men begin to lose heart and the people tend to desert the worship of their own god Yahweh for the worship of the Canaanite Baal and Ashtaroth (Bel and Ishtar)

Joshua dies after his death the Judges become rulers of the people They mix their race with the Philistines with the Hittites and so forth and became as they have always subsequently been a racially mixed people Under a series of wise men and heroes they wage a generally unsuccessful and never very united warfare against their enemies In succession they are conquered by the Moabites the Canaanites the Midianites and the Philistines The story of these conflicts of Gideon and of Samson and the other heroes who now and then cast a gleam of hope upon the distresses of Israel is told in the book of Judges In the first Book of Samuel is told the story of their great disaster at Ebenezer in the day when Eli was Judge This was a real pitched battle in which the Israelites lost 30 000 (?) men They had previously suffered a reverse and lost 4000 men and then they brought out their most sacred symbol the Ark of the Covenant of God (Wells s *Outline of History*)



[Department of Antiquities Jerusalem

THE ARK OF THE COVENANT

There are no traces of the Ark of the Covenant extant and the descriptions of it are not detailed but this sculptured representation of the Ark on a wheeled carriage from a synagogue of Græco Roman times at Capernaum may be presumed to be founded on a traditional description

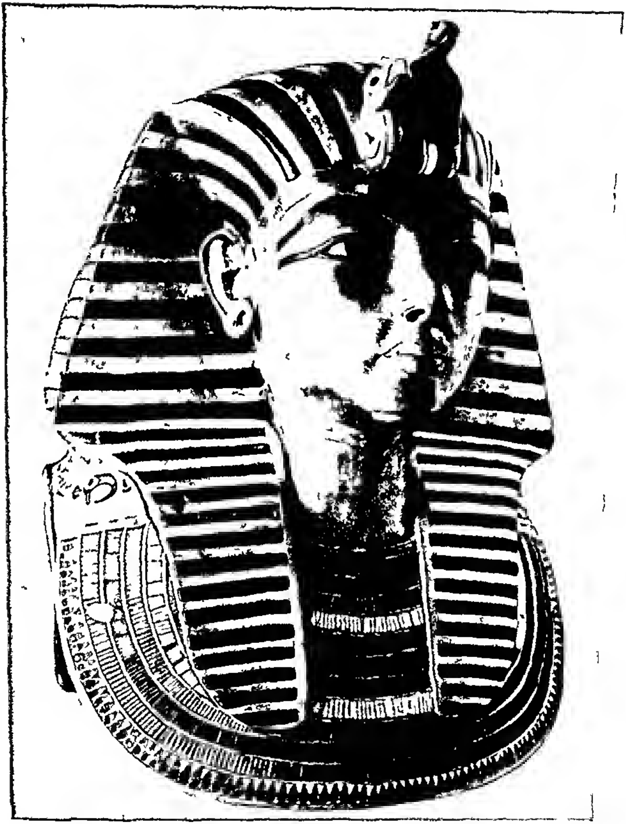
How the Philistines were at first smitten with terror at the sight of the Ark and of the great shout that went up from the Israelite host we read in the first Book of Samuel

And when the ark of the covenant of the Lord came into the camp all Israel shouted with a great shout so that the earth rang again And when the Philistines heard the noise of the shout they said What meaneth the noise of this great shout in the camp of the Hebrews? And they understood that the ark of the Lord was come into the camp And the Philistines were afraid for they said God is come into the camp And they said Woe unto us! for there hath not been such a thing heretofore Woe unto us! who shall deliver us out of the hand of these mighty Gods? these are the Gods that smote the Egyptians with all the plagues in the wilderness Be strong and quit yourselves like men O ye Philistines that ye be not servants unto the Hebrews as they have been to you quit yourselves like men and fight

And the Philistines fought and Israel was smitten and they fled every man into his tent and there was a very great slaughter for there fell of Israel thirty thousand footmen And the ark of God was taken and the two sons of Eli Hophni and Phinehas were slain

Now we come to the dramatic story of the three Kings Saul David, and Solomon

(*To be continued on page 103*)



TUT ANKH AMEN

After a photograph by Mr Harry Burton of the Metropolitan Museum of Art New York World copyright strictly reserved

The greatest archæological event of this century was the discovery of the tomb of Tut Ankh Amen in the Valley of the Tombs in Egypt The magnificent equipment of his tomb is described and illustrated in the text The excavation of the tomb was carried out by Mr Howard Carter, in association with Lord Carnarvon

BOOK I—(*Continued from page 18*)

SCIENCE AND MODERN THOUGHT

CHAPTER II

NEW LIGHT ON THE EVOLUTION OF MAN

§ 1

IN this summary of present-century developments we cannot omit some reference to the new light that has been thrown on evolution problems. In Book II the subject of evolution will be fully dealt with; here we shall only refer in a general way to the advance of knowledge in this realm of science.

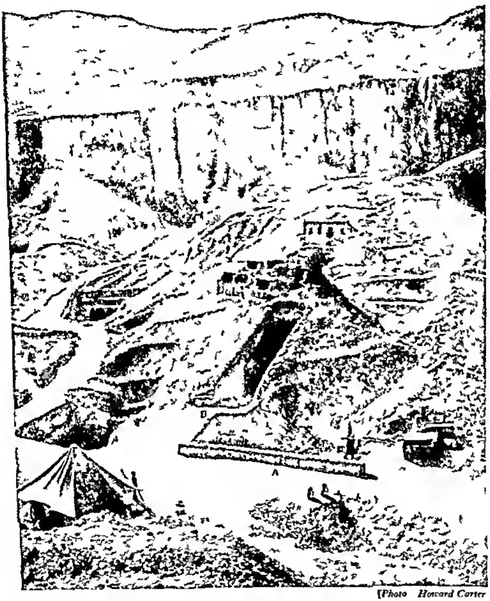
To begin with, and before we come to other problems of evolution, let us turn to new discoveries relating to the antiquity of Man. Here much new knowledge has accumulated quickly. In an introduction to his important book, *New Discoveries Relating to the Antiquity of Man*, published in 1931, Sir Arthur Keith wrote these words: "Such is the rate of advance we are now making in this branch of knowledge that in five years' time my hand, or another's, will have to add a supplementary volume to the new work."

In a preliminary note on these discoveries we may glance backwards. Anthropologists may sometimes differ on points of detail or in assigning probable dates to fossil remains, but there is no doubt as to the great antiquity of man. The ancestor of man when approaching the human standard in size of brain arose soon after the commencement of the Pliocene period. Let us say about 400,000 years ago. He is called "Dawn man" (*Eoanthropus*), and he was living in Sussex in the early Pleistocene. We know little about Dawn man, but it is impressive that anthropologists with marvellous skill and ingenuity can tell us something of ancient man as he existed as far back as 200,000 years ago. Such is the skill of the experts that they can reconstruct the type of man from a few fossil remains, an unearthed skull, or even—sometimes too boldly—a single tooth.

We shall not encroach on a subsequent chapter to be devoted to the evolution of man, and there is no need to debate the question of man's emergence from a generalised stock common to him and the anthropoid apes. The answer of science to that is an emphatic yes. It seems certain, too, that it is not from any *living* form of anthropoid (man-like) apes that man took his origin. Each, however, ape and man, would seem to branch from a common stem on the evolutionary tree of life. According to present estimates, Sir Arthur Keith says that separation from a common stem took place something like a million years ago.

Perhaps it should be noted (1) that some authorities, like Keith, are of opinion that the Hominoid (tentative men) line diverged from generalised Anthropoids; (2) that others derive the Hominoids from a stock common to them and to the Anthropoids; and (3) that others, like Osborn, believe that the Hominoids broke away at a lower level—from a pre-Anthropoid monkeyish or Simian stock. These differences of opinion are not surprising, since the inquiry is still relatively young.

6



[Photo Howard Carter

View of the Royal Cemetery showing the relative positions of the Tombs of Tut Ankh Amen (*a*) and Rameses VI (*b*)

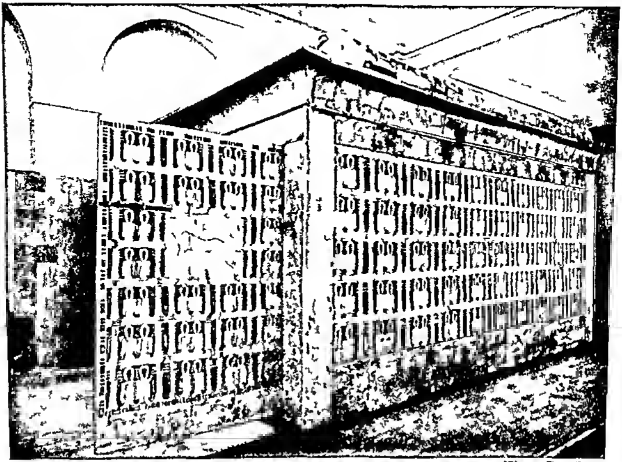
Tut Ankh Amen, with its astonishing contents almost intact, by Mr Howard Carter (associated with Lord Carnarvon's expedition) in 1922 The whole thrilling narrative and a detailed description of the contents of the royal tomb will be found in Mr Howard Carter's three volume work, ' The Tomb of Tut-Ankh-Amen,' which contains hundreds of illustrations

The youthful Pharaoh was politically an unimportant sovereign, and his fame only rests on the discovery of his tomb and its truly magnificent equipment In Tut Ankh-Amen's time the Kings of Egypt were buried in secret places, in tombs hidden away from human eyes, in vast rock hewn galleries in the face of the Nile cliffs known as the Valley of the Tombs of the Kings Even at a remote date many of the royal tombs had been discovered by robbers and plundered of their treasures

Tut-Ankh Amen was a young man and probably reigned about six years He died nearly 3,400 years ago It took Mr Howard Carter eight seasons (October to April) to recover all the magnificent treasures the royal tomb contained, how magnificent readers will learn from Mr Carter's fine description and photographs in the book referred to It was a wonderful moment for Mr Carter when some excavation work on the side of a small hillock in the Valley of the Tombs revealed a roofed-in passage, ten feet high and six feet wide, by and by there was disclosed the upper part of a doorway, blocked, plastered, and sealed " It was a thrilling moment," writes Mr Carter " Alone, save for my native workmen, I found myself, after eight years of comparatively unproductive labour, on the threshold of what might prove to be a magnificent discovery Anything, literally anything might lie beyond that passage, and it needed all my self control to keep from breaking down the doorway and investigating then and there Was it actually the tomb of the King for whom I had spent so many years in search? "

It was But even Mr Carter did not imagine what a great discovery it was to turn out to

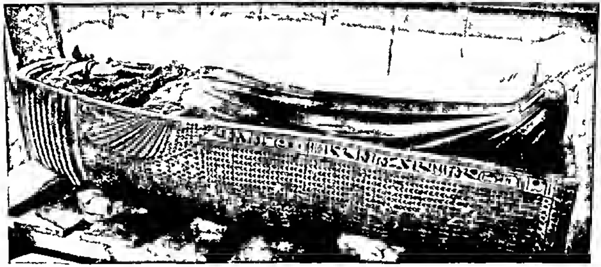
(*Continued on page 70*)



[Photo Harry Burton

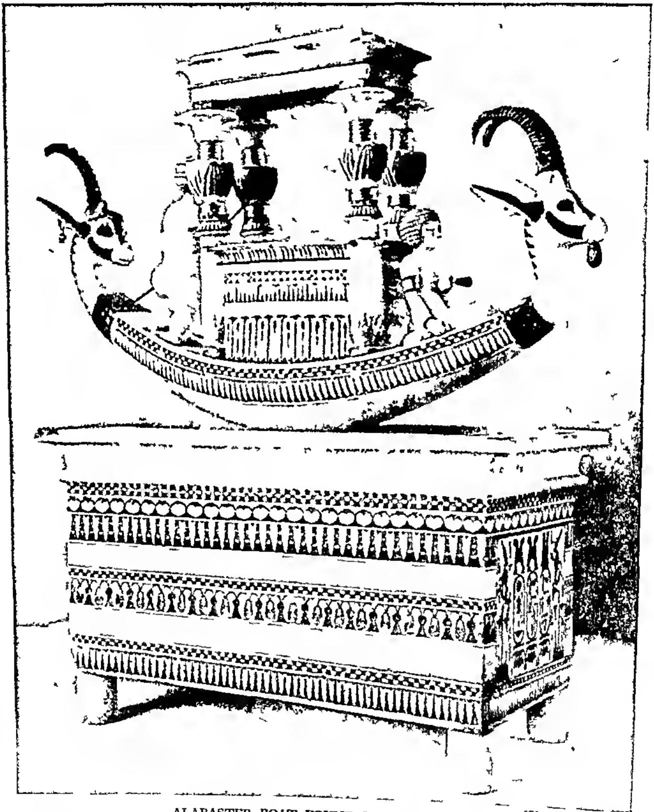
ONE OF THE SHRINES IN TUT ANKH AMEN S TOMB

In the Tomb there were four golden shrines (nested one within another) the innermost one enclosing the sarcophagus The above photograph is of one of the outer shrines with massive folding doors the panels wonderfully decorated with blue faience repeating magic symbols intended to ensure security



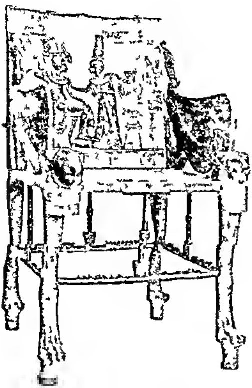
[Photo Harry Burton

"The third (innermost) Coffin of Gold covered with linen shroud and floral collarette as it lay in the shell of the second coffin (Carter)



ALABASTER BOAT FOUND IN THE ANNEXE [Photo Harry Burton

This beautiful alabaster boat is a perfect masterpiece of carving in alabaster Perhaps it represents a funerary barque for the celestial journey of the Good God —the King At the helm of the ship is a dwarf slave, and a dwarf girl holding a lotus flower to her breast is placed towards the bow The carving on the stand is of wonderful craftsmanship



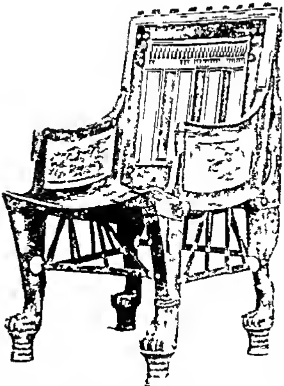
TUT ANKH AMEN S ARMCHAIR

(Continued from page 67)

be The doorway he found led to the great Antechamber which in turn gave access to the Sepulchral Hall It took over forty months' work to clear out that royal tomb! We cannot enumerate here the magnificent treasures found That takes three volumes In front of the actual burial chamber there was an immense gilt shrine like a golden wall built to cover and protect the sarcophagus an enormous chamber (seventeen feet by eleven feet and nine feet high)— from top to bottom it was overlaid with gold and upon its sides there were inlaid panels of brilliant blue faience, in which were represented repeated over and over the magic symbols which would ensure its strength and safety

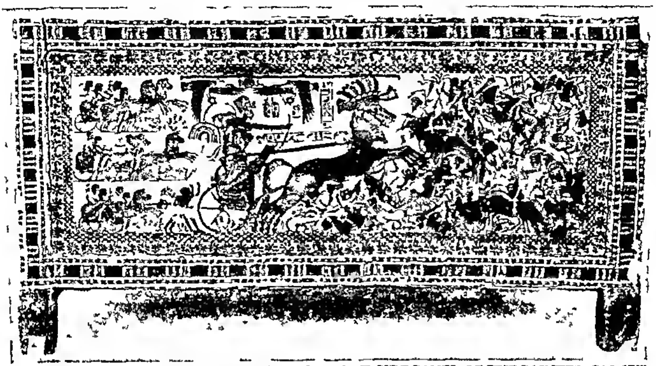
Around the shrine there were a number of funerary emblems and at the north end the seven magic oars the King would need to ferry himself across the waters of the underworld The walls of the chambers were decorated with brilliantly painted scenes and inscriptions brilliant in their colours" There were also other chambers, or annexes full of treasures

Among the treasures were the great golden mummy case of exquisite workmanship, miniature gold coffins (that contained the viscera of the King), elaborately inlaid in feather design, the King's golden throne, beds carved in solid ebony, and foot panels of ebony, ivory, and gold, such things also as the King's sceptre of gold and lapis lazuli blue glass, large cedar wood caskets inlaid and veneered with ebony and ivory with splendid schemes of ornamentation on the panels, made up of multitudinous human figures in every kind of action, beautiful alabaster vases, gold plated statuettes of divinities and numbers of ornaments of all sorts and silver and faience vessels But these are but a few of the things that could be enumerated The few illustrations we are able to give here are from Mr Carter's volumes



A CHILD'S CHAIR REMOVED FROM THE TOMB OF TUT ANKH AMEN

This small chair probably the King's when a child is carved of ebony and inlaid with ivory It has antelope and floral devices of embossed gold on the panels of the arms



SCENE IN MINIATURE PAINTING UPON THE RIGHT SIDE PANEL OF THE PAINTED CASKET

" the King is represented slaughtering his northern or Asiatic enemies The whole mass of this ornament, like that of the left panel is made up of multitudinous human figures in every kind of action The King is shown in his chariot drawing his bow, his sheaves of arrows rattling at his sides, and the slain falling under him as before a pestilence ' (Carter)

(*Continued from page* 66)

Arthur Keith says "What will Mr Taungs and Mrs Taungs be like when we have been so fortunate as to find them? Professor Dart (the discoverer) expects them to be upright beings like ourselves and more man-like than any known anthropoid, whereas I expect that they will prove to be just rather big-brained anthropoid apes" He thinks this human-like ape came upon the scene after man's emergence was an accomplished fact "In brief, the discovery at Taungs has given us not a human ancestor but an extinct cousin of the gorilla and chimpanzee"

World-wide Discoveries

A final answer, however, to the question, "Where did man emerge?" is not yet possible; more data must be forthcoming first Some authorities are in favour of Asia as man's place of origin Meanwhile the converging evidence of man's emergence has come from widely scattered countries

It appears that "there was a time when Palestine was inhabited, just as Europe was, by that uncouth species of humanity we call Neanderthal man" The Neanderthal species of man is an extinct species widespread in Europe probably some 250,000 years ago,* he was a true Homo, but with Simian characters "swarming in the details of his structure" In "The Robbers' Cave" in the hills, situated high up on the northern side of a ravine overlooking the Sea of Galilee, there was discovered in 1925 the "Galilee Skull" of Neanderthal type The discoverer, Mr Turville-Petre, "by a fortunate turn of the spade carried the history of Palestine far beyond the oldest records of Egypt or of Babylonia—to a time when that part of the East which much later became known as the Holy Land was the home of a strange and primitive type of humanity"

We pass from Palestine to China Here, too, recent fresh discoveries were made near Peking in 1928 and 1929 The Peking man has been named "Sinanthropus" (Peking man) and Sir Arthur Keith remarks "the discovery of this

* Some authorities would place the date farther back.

primitive type is one of the most important events which have marked the opening up of man's early history" It equals in importance the discovery of Java man (*Pithecanthropus*—Ape-man, discovered 1892), of the Piltdown Man (Sussex, 1911–12), and of Neanderthal man The date is early Pleistocene, which means an antiquity of towards a quarter of a million years, according to geological reckoning Peking man, on the opposite side of the world, existed about the same remote period as the Piltdown man in Sussex, representing "one of the earliest and most generalised forms of humanity known to us at present"

Another astonishing discovery which must be mentioned was the "London" skull, unearthed in Leadenhall Street, London, while the foundations were being dug for Lloyd's in 1925 Once more we quote Keith "Many and interesting as are the discoveries which have been made in all parts of the world, I would give the pride of place to one made at home" (the one referred to) The specimen belongs to the Piltdown breed of men, a lineal descendant "It is possible that Piltdown man does represent the early Pleistocene ancestor of the modern type of man He may well be the ancestor we have been in search of during all these past years"

Sir Arthur says "modern type of man," other discoveries being of *extinct species* The world has seen a succession of human types which have become extinct, and man's exact relation to the apes remains to be settled In *Pithecanthropus* we have a being approaching the threshold of humanity, in Heidelberg Man (discovered 1908) perhaps in the same genus, a massive, chinless, ape like jaw, in the *Peking man*, a being on the point of crossing the threshold, in Piltdown man the essential features of humanity are evident—very near, Sir Arthur Keith says, to the ancestor that anthropologists have long been in search of, the ancestor of modern races of mankind

We may note that all the discoveries mentioned have been made within the last thirty years, with the exception of Java man, not one of them, of course, was known to Charles Darwin The search is yet young, and possibly startling discoveries are in store We have now the evidence of an almost world-wide distribution of primitive stocks of mankind The ascent of man is assuredly becoming more and more clearly deciphered and his pedigree traced

§ 2

LET us try to bring this into some kind of chronological order One can frame no table of agreed dates No such thing is possible, so widely do authorities differ, for various factors enter into the calculation and so much is conditional But approximation is sufficient to impress us with the vast periods of time involved in the successive steps of man's evolution The earth is estimated to have existed *two thousand million* years Life first appeared on earth (as some estimates put it) *three hundred million years* ago The *geologic life period* of the earth is reckoned at *one thousand million* years But it is only one-thousandth part of that time, that is to say, only something like *one million* years, since the emergence of man's first ancestors from a generalised stock common to them and to the anthropoid apes The generalised anthropoid hominoid stock is supposed to have diverged *into three main branches*, one branch leading towards man, another towards the gibbons the third towards the higher apes, namely the gorilla, the chimpanzee, and the orang On the whole the gorilla is our nearest living relative

In regard to dates four points should be noted (1) the position or grading of this or that type in the evolutionary series is a question for the anatomist, who bases his judgment on skeletal characters, especially those of the size and shape of the cranial cavity where the brain lies (2) The age, *on the other hand, is determined* by the geologist who bases his judgment on the nature and position of the deposits in which the remains are found, on the associated remains of other creatures, and, in some cases, on traces of man's handiwork (3) There is great quantitative diversity in the remains, thus there are many skeletons of Neanderthal Man, but only two broken Piltdown skulls (4) Little attention need as yet be paid to estimates of age in terms

ON THE TRAIL OF ANCIENT MAN

The photograph is of an expedit on caravan led by Dr Roy Chapman Andrews in the sand dune country south of Tsagan Mor in Mongol a Some authorities suppose the home of the remote ancestors of man to have been in Northern As a

of years but it is important not to mix up the figures given by different explorers For the *proportions* of time in the various cases are of more value than the figures as such, and the proportions are obscured if its figures are taken from different experts

We have to imagine a growing tree of life from whose main stem at long intervals branches spring and also one branch from another branch These branches represent di vergent lines of evolution

Beginning with the emergence of man s first ancestors over one million years ago we make a jump to about 600 000 years ago when *Pithe canthropus* the Erect made his appearance

Perhaps 100 000 years later there arose and we find *Eoanthropus*, a being approaching the threshold of humanity

Another long interval of tens of thousands of years and then we find the Neanderthal race, living in Europe, for a period extending over more than 100 000 years, continuing to near the end of the last Glacial epoch

Homo Sapiens

Thus Neanderthal race is dispossessed say 50 000 years later by Cro Magnon man—the first *Homo sapiens*

The present interpretation of Neanderthal man looks upon him as a separate and peculiar species of man which died out during or soon after the Mousterian period" (Keith) He was ancestral to modern man and had retained, as Lull says an unusual share of ape like traits He existed as we have seen during the Old Stone Age Here again there is no well defined chronology There is overlapping in these vast periods and our chronology does not apply to anything more than restricted regions Also the Old Stone Age gradually shades into the New The Neanderthals were the first cave dwellers, and were perhaps ousted by Cro Magnon man, who had advanced from the confines of Asia and Europe to Western Europe He was a great advance on the Neanderthal type

It is just because cave man dwelt in caves and buried his dead that anthropologists have been

able to get so complete a knowledge of ancient man The predecessors of Cro-Magnon man, the Neanderthal race, "occupied the plains, plateaus, and river drifts of Austria and Germany, Spain and France and England The remains of their stone industries and flint making camps are found in the great river drift deposit near Heidelberg, in the ancient river drifts of Cromer on the East Anglia coast, and on the higher and middle river terraces of France and England This nomadic life in the plains, plateaus, and terraces lasted perhaps for 600,000 years, if we can trust the glacial records Then at the onset of the third great glaciation from Scandinavia began the cave period" (Osborn)

The Cave-dwellers

The second cave dwellers, as we have remarked, were the Cro-Magnon race, the true *Homo sapiens* In their structure and their workmanship they reveal fine qualities, and we see the beginning of man's cultural evolution The Cro Magnon man, or man of the cave period, lived between the third and fourth Ice Ages—say, about 50,000–30,000 years ago Says Professor Rowland Angell "There is certainly no reason, culturally speaking, why we of the twentieth century A D should be ashamed to claim kinship with and acknowledge indebtedness to that sturdy pioneer stock," the stock whence modern man sprang The typically human phase of evolution had begun These cave men were men of modern type, in size and *pattern of brain equal to the present day* For very many thousands of years man has been substantially the same kind of physical being as he is to-day

The conditions of life for these cave men were hard *It was intensely cold, and in the middle* of the Old Stone Age they were driven from their open-air nomadic life to the rocky shelters and to caverns for protection against the oncoming ice-cold blasts of the great Scandinavian glaciers They clad themselves *in skins*, they were unacquainted with agriculture; they had no domestic animals, they were hunters, fowlers, and fishermen, living an active, strenuous life It was the day of the cave-bear and the cave-lion, *the hyæna*, the mammoth, and the woolly rhinoceros, the red deer and the wild horse, on which the hunter fed They had no timber huts, no buildings of any kind, and cultivation of grain or vegetables was unknown

We may speak of them as "splendid savages," but before the beginning of the New Stone Age they had developed remarkable intellectual qualities and an artistic ability The latter may have been first aroused by the *open-air nomadic* life of the plains and open valleys, while a more leisured life in caverns may have fostered intelligence They reverently buried their dead There is no doubt about their artistic gifts, strikingly abundant cave drawings and paintings, in many colours, have remained to proclaim the fact The cave walls were *decorated* with engraved and painted representations of animals, done with wonderful faithfulness, freedom, and spirit The art of painting and sculpture had its birth in the imagination of the Cro-Magnon race Twenty-five thousand years ago they occupied a large part of western Europe But long before that date the three-colour paintings of animals discovered in a cave near Santander, in Spain, were made They are said to be fifty thousand years old

Dawning Civilisation

In what is only a short summary we shall not enter further upon this interesting phase of the dawning of intellectual and spiritual life among *the Cro Magnon race of cave-dwellers* *While* they lived in Western Europe we see the first manifestation of the artistic spirit, arising from highly developed mental faculties

These men of the cave period had at first little *knowledge of fire, and no knowledge of bronze* or iron, their tools were shaped from stone; but as a medium of expression they became familiar with the use of modelling clay, adepts in sculpturing stone, in engraving and painting *from models* *Their* cavern walls, covered with designs of beautifully finished work, show what remarkable technique they acquired In Professor Osborn's recent book, *Man Rises to Parnassus*, the reader will find the most fasci-

nating description of the caverns in the Pyrenees and Dordogne regions

The cold of the last glacial period passes away about 13 000 years ago, and after a transitional interval a period of prehistoric civilisation opens "The prehistoric civilisation of western Europe is now accelerated by the successive arrivals of new races of man bringing new arts and industries from western Asia, where prehistoric civilisation was far more rapid owing to the increasing aridity of the country and the absence of forests The arrivals from the east and from north Africa bring the micro flint industries (13 000 B C) and the *Neolithic art* of agriculture, later the copper and bronze industries, and finally, 600 B C, iron" (Osborn) Thus, continues Dr Osborn, "within a period of 8,000 years our ancestors arrived in north-western Europe and Scandinavia and passed a long hunting stage of evolution with only flint implements, through all the Neolithic phases, through a superb development of the art of both flint and bronze, and into the culminating period of the age of iron"

From Ape to Man

Science cannot in its present state give a full and explicit answer to the question what biological processes have transformed ape into man Was it all a mere mechanical affair, a matter of changing anatomical structure changing environment, adaptation, and changing habit? These things in themselves would not change anthropoid apes into human beings In the evolution of man from ape what played the part of the human brain? Sir Arthur Keith answers, "We who believe that man has been evolved are certain that the power which moulds, shapes, and modifies the human body is not situated outside the body but is an inherent quality of its living flesh" But he adds, "Far be it from me to claim that science can, in its present state, return a full and explicit answer to the question" One day, perhaps, science may be in a position to explain how humanity made its exodus from apedom Every year sees an increase of our knowledge of the biological processes of the human body If the present progress continues, Sir Arthur Keith, in a vein of humour, says, "books which are sealed to us will be open to our successors of A D 50,000" A longish time to wait!

"Before we can determine whether it is possible for man and for the gorilla to come independently by their structural adaptations to posture—and therefore by their resemblances—it is necessary to know how Nature has changed the anthropoid into a human form In course of time we shall know how such changes are effected, they are effected by means which are released by living protoplasm during the development of a fertilised egg be it human or anthropoid Habit and environment may elicit the qualities which are inherent in living brain and muscle, but habit and environment cannot endow living muscle or living brain with qualities which are not already born in them The clue to the rise of humanity lies hidden in that great, almost uncharted field of knowledge which covers the transformation of the fertilised human ovum into the grown man and woman Until these unknown territories are explored and conquered it is idle to ask why we who were Eocene Tarsioids have been chosen to be men and women, while another Tarsioid ended as the goggle eyed *Tarsius spectrum* of Borneo"

There remains the question what is it in the brain that makes one animal "higher" than another, and what relation has the brain itself to "intellectual" powers? Sir Arthur Keith makes the statement that in brain equipment no advance has been made since the Cro Magnon Man of 30 000 years ago, modern man has made no advance in brain equipment since then "Beyond a doubt the brains of the Cro Magnons were in size and pattern the equal of the best modern" Before we come to this question let us see how the evolution theories of to day stand

§ 3

THE point we note, then, is that man is far more ancient than he was supposed to be a couple of decades ago, and his initial development slower His *oneness* with the evolutionary process becomes more and more clear This

leads men to speculate about the future Osborn expresses a personal view when he writes "We have discovered that races, 'species,' and stocks of man arise in the same manner that races, species, and genera arise among other mammals A burning question of the present day is whether man is destined to rise or to fall, and many and varied answers are being attempted The rise of primitive and uncivilised man is subject to the same laws as those which prevail throughout the animal kingdom, until human civilisation steps in and interferes with the natural order of things Thus when man begins to specialise and human races begin to intermingle, Nature loses control It appears that the finest races of man, like the finest races of lower animals, arose when nature had full control, and that civilised man is upsetting the divine order of human origin and progress Several recent writers on the subject of the future rise and development of man, among them Bury, Inge, and Conklin, take a decidedly pessimistic view They are no doubt under the influence of the shock of the great World War, which they regard, and in a measure rightly so, as a calamity of the first magnitude in contrast to the optimism of the Victorian period"

Professor Osborn goes on to illustrate modern race deterioration, attributing it to various causes "Race deterioration appears to prevail throughout the world to-day Our policy seems to be that of care for the individual neglect for the race This doctrine of individualism, so rampant everywhere, is the greatest deterrent to racial progress The future rise of man is intimately related to that of the special race to which he belongs This is true not only of his physical nature but of his mental and spiritual nature as well—they too depend on the mental and spiritual ascent of the race of which he is a unit Every race has a different kind of soul—by soul is meant the spiritual, intellectual, and moral reaction to environment and to daily experience—and the soul of the race is reflected in the soul of the individual that belongs to it This racial soul is the product of thousands of years of past experience and reaction—it is the essence or distillation of the spiritual and moral life of the race . . Racial consciousness is not pride of race, but proper respect for the best qualities and characteristics which each race possesses . . .

"When our understanding of the spiritual, intellectual, and moral, as well as physical values of races becomes more wide-spread, the course of the rise of man to Parnassus will again take an upward trend and the future progress of the human race will be secure"

On the importance of the respective qualities and characteristics of individual races Sir Arthur Keith has expressed similar views in his Rectorial Address, *The Place of Prejudice* (1931)

Mr H G Wells, among modern thinkers, is one of those who dissent from a good deal of all this He has a different point of view He believes that good would result from racial mingling, he is in favour of "one human community" Until that comes about Mr Wells foresees a continuation of trials and dangers Nevertheless he believes in progressive civilisation and its accumulating life and power At the conclusion of his stimulating recent book, *The Work, Wealth, and Happiness of Mankind*, he writes

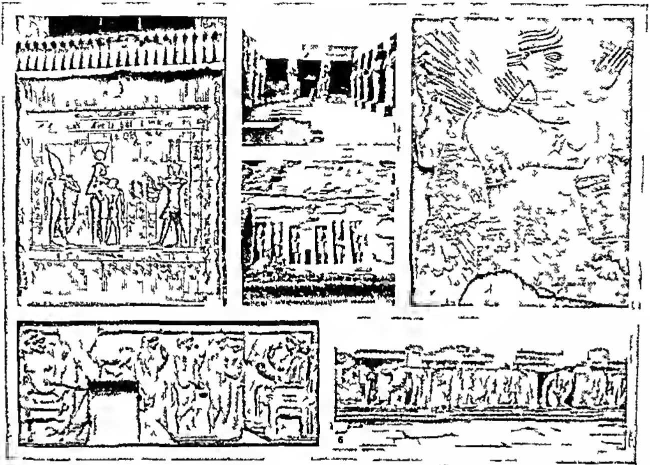
"What is the culminating effect of a survey of history, of the science of life, and of existing conditions? It is an effect of steadily accelerated growth in power, range, and understanding All these things lead up to us—and how could they seem to do otherwise? Progress continues in spite of every human fear and folly Men are borne along through space and time regardless of themselves, as if to the awakening greatness of man"

But we are going somewhat beyond the scope of this short summary, maybe, however, it has served to throw out some hints for thinking minds

(*Continued on page 80*)

Supplement Illustrating

PRE-HISTORIC SCULPTURE, PAINTING, AND DRAWING

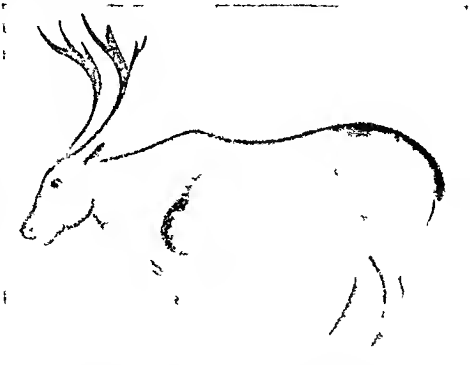


(By courtesy of the Encyclopaedia Britannica

1 Relief panels on the birth house of Isis at Dendera Egypt depicting Isis feeding her son Horus the father Osiris and Ra the highest God offering a gift
2 Massive carving in the Mortuary Hall of Rameses II at Karnak Egypt
3 Carvings adorning the wall of the Temple of Hathor at Abu Simbel Egypt as they appear when viewed from the hill
4 Relief from the palace at Ashur Nasirpal ninth century B C Assyria
5 Relief from Harpy tomb in Xanthos predecessor of many other Lycian tombs of the fourth and fifth century
6 Complete frieze of the Theatre of Dionysus at Athens Greece

THE arts and crafts in Egypt were highly developed in remote antiquity From the First to the Thirty first Dynasty marked a history of over 4 000 years (The date of the First Dynasty is not certain while one authority would date the first Pharaoh at about 4 000 B C another places it 2 000 years earlier than that The Pyramid Age is about 3 000 to 2 500 B C)

Most people who know something of the magnificence of ancient Thebes and Karnak and other marvels of ancient Egypt are probably less familiar with the civilisation and arts of ancient Assyria and Babylonia There was a time when the extent of their splendour was a matter of doubt It is one of the most remarkable facts in history, as has been said that the records of an empire like Assyria so renowned for its power and civilisation should ever have been so entirely lost even the very site of the great Nineveh itself Now we know as much of its ancient splendour its art and crafts its great buildings and palaces the sculptured monuments of its ancient kings its library of clay inscribed books and the life of the Assyrians as we know of Greece and Rome

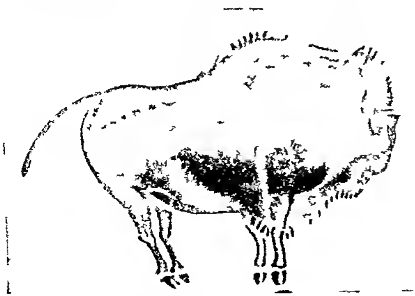


PRE-HISTORIC ART OF THE CAVE-DWELLERS

It was in the period when men lived in caves 50 000 years ago that they made the first step towards picture painting. The illustration of the Reindeer is reproduced from a three colour painting discovered on a wall in a cave at Dordogne Southern France (*See page* 74)

Exact chronology of these far off times is unsettled but we know that before the time of Assyria and Babylonia the Sumerian race had developed a high civilisation They were perhaps the earliest people to form real cities in this part of the world, or indeed in any part of the world and their origin is mysterious

The monumental sculptures of Assyria and Egypt still remain a living force and influence Excavations at Nippur one of the ancient cities of Babylonia unearthed evidence of a city community existing there at least as early as 5 000 B C, *and probably as early as 6 000* B C *an earlier date than anything we know of in Egypt The Egyptians lavished their money and art on temples and on the tombs of dead kings and Babylonians and Assyrians on their palaces which in a sense were regarded as sacred edifices the kings being representatives on earth of their deity When building a palace or temple the Assyrians had a similar ceremony to our laying of the foundation stone and excavators have found cylindrical tubes covered with writing placed in little niches at*



Polychrome picture of a bison from Altamira (Cantabria)

the corners of the foundations, facing the four points of the compass. As historical records, the bas-reliefs from Babylonia and Assyria have proved of priceless value, preserving for us records of historical facts that otherwise would not have been known.

In other directions priceless examples of decorative art, the finest pieces of engraved metal work, exquisitely painted vases and so on still exist to speak of the achievement of these ancient peoples; some of their outline drawings are not surpassed by modern art. Each phase of civilisation has produced its own form of art. The ancient Greeks brought sculpture to a point of perfection and physical beauty which has never since been surpassed.

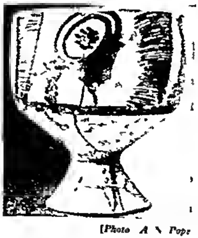
[*Courtesy of the Illustrated London News*

A survival of Mycenæan ornament of 3,000 years ago. A funerary amphora found to contain charred bones with two brooches and two stick-pins of iron, then a precious metal.

BEAUTIFUL VASES ILLUSTRATING THE ART OF 6,000 YEARS AGO

[*Photo: A. N. Pope*

A beautiful alabaster vase showing a natural pattern of greyish-white and brown. Along with the vase illustrated opposite it clearly demonstrates the highly advanced stage reached by pre-historic art in Northern Persia.



[*Photo: A. N. Pope*

A Persian ibex bowl dating back to the period of Hissar I (about 4,000 B.C.). The horns of the animal enclose the sun symbol, and the branch shaped enclosure may represent forest.

[*Photo: Harry Burton*

An alabaster vase beautifully carved with ornament and an incised inscription covered with pigment. From the annexe of Tut-Ankh-Amen's Tomb.

A RECONSTRUCTION OF THE JAVA MAN

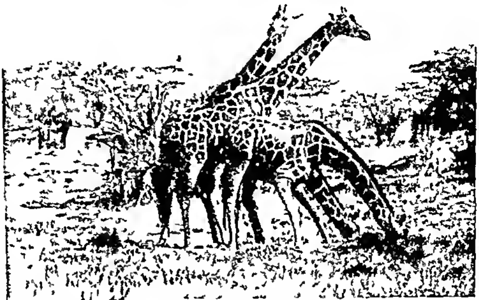
Pithecanthropus erectus

According to Sir Arthur Keith *Pithecanthropus* was "a being human in stature, human in gait, human in all its parts save its brain." His remains, consisting of a skull cap, a thigh bone and two back teeth, were found by Dr Eugene Dubois in 1894 in Trinil, Central Java, in fossiliferous beds which date from the end of the Pliocene or the beginning of the Pleistocene Era. (See page 72.)

1 The fact of heredity All organisms tend to resemble their parents

2 The fact of variation No two organisms are exactly alike Thus the resemblance between parent and offspring is not absolute Further, some variations at least are inheritable

3 All organisms produce more offspring than can survive If all or even half, the young even of the slowest-breeding known animal, the elephant, were to come to maturity and themselves reproduce, the whole globe would in a limited time become packed with elephants While what would happen if all the millions of eggs of every sea urchin came to maturity baffles imagination! Thus, among the individuals of every species there is of necessity a *struggle for existence*—not necessarily a conscious struggle, but none the less a real competition in effect



GIRAFFES FEEDING [Photo Underwood Press

According to the pre Darwinian theory of natural selection advanced by the French naturalist Jean Baptiste Lamarck the giraffe acquired its long neck through long continued efforts to reach the foliage of acacia trees, upon which it likes to feed This theory is now discredited

The conclusion to be drawn is this—that those individuals which possess variations helping them in the struggle will on the whole survive, while those which have varied in the opposite direction will on the whole be killed off Those that survive will reproduce the race and by the operation of heredity their offspring will tend to resemble them—in other words, will tend to possess the same favourable variations This process Darwin called *natural selection*

Natural selection may thus be compared to a sifting of the individuals of a race, a sifting which results in the race coming to consist only of such individuals as are best *adapted to their environment*

For the moment we shall neglect the various kinds of "selection" that have been distinguished and described, for a good many facts have been discovered since Darwin's day Evolution depends on new departures, new peculiarities, divergencies, freaks, sports, "a little more of this, a little less of that"—in short, organic or constitutional changes *These are technically called variations or mutations* They have been called the organism's experiments in self-expression, and they are the raw materials of progress

Lamarck's Theory

Lamarck, the great French naturalist, died in 1829 at which date Charles Darwin was only nine years old Lamarck's theory of the method of evolution was different from that of Darwin's, and in its original form is abandoned Lamarck taught that the great factors in evolution were to be looked for partly in the action of the physical conditions of life, partly in the use and disuse of bodily functions in other words, in the effects of habit For example, the giraffe acquired his long neck by his efforts to browse upon the foliage of acacia trees To avoid intricacies we are putting the Lamarckian theory broadly That theory does not command assent now

It is not believed by the best authorities that individually acquired characters are transmitted to the offspring, or are cumulatively "fixed" in the course of generations It is not believed, that is to say, that they account for the big facts of heredity Some peculiarities of an individual

are heritable, others are not By inheritance we mean the transmission of characteristics from one generation to another

By the big facts of heredity we mean the facts that account for the origin of new *qualities, new* departures, new species Heredity in its wide *sense is the relation of organic continuity between* successive generations In the narrower sense there would still be heredity though evolution stopped, in the bigger sense there could be no evolution without heredity

Inheritance means the transmission of qualities, or characters, from one generation to the next Among the individuals of a species some *new* quality or variation may spring up, if that in the long run helps the individuals of the variation species in the struggle for existence, *it* will *survive,* and be *reproduced in the race* it becomes fixed It is here, then, that natural selection comes in

How do "Variations" Arise?

Natural selection is a sifting process, sifting the mutations, or variations, that arise, those which are in the "right" direction are preserved That is to say, mutations favouring the survival of the "fittest' are perpetuated, their qualities become the inheritance of the race These mutations, or variations, must arise before natural selection can get to work, natural selection, as J B S Haldane puts it, can only act when it finds variations to act on Which raises the question *How* do these spontaneous variations arise?

Before we can begin to consider that unsolved problem we have to turn to a particular branch of knowledge that was not even known in Darwin's day, some of it not even known at the beginning of the present century Suppose instead of asking *how* do variations arise, we ask *where* do they originate? What is the genesis of hereditary variations?

§ 2

WE assume that every reasonably intelligent person knows that each individual life begins as a single fertilised cell, which gives rise to other cells, which continue to divide and grow until the whole complex structure of an individual is produced The activities of a many-celled organism, like the human body, are the co ordinated effects of the activities of the *component cells Every cell* has *an individual* life, as the late Sir Ray Lankester puts it, "*those* animals and plants which are built up of many cells, of many varieties, may be considered as composite organisms—cell-states or communities in which the individual cells, all derived from one original mother cell, are the citizens, living groups and habitations (tissues) having their different occupations and capacities, carrying on distinct operations, and working together for the common good, the 'life,' as we call it, of the individual plant or animal which they constitute"

Protoplasm has been called "the physical *basis of life*", *it is the substance in us which* "lives," and protoplasm is the basis of the cell *In the* development we see the *protoplasmic* germ cell giving rise to other cells, then organs, *then finally* organism *Every* new *life typically* begins with the fusion of two germ cells, one paternal and one maternal Our complex bodies thus spring from one single cell In most cases this single cell, the fertilised egg cell, is formed by the orderly union of two cells, one paternal and one maternal—in animals the sperm and the ovum

It is important for what we are to say about inheritance to remember that in the development of the body some of the *germ cells* remain apart, keeping by themselves, *they are the originators* of the future reproductive cells of the mature animal *The egg cell is the mother of all the cells in the organism,* the future reproductive cells included In the fertilised egg cell "the rich inheritance, the fruition of ages" is somehow condensed The new knowledge that has come to us in recent years is that *the germ cells hold the secret problems of heredity*

A Big Puzzle

We are trying to avoid intricacies so that the uninstructed reader may not be smothered in the meshes of too many details, sufficient to say, then, for the present, that the cell contains certain minute rod like bodies called

Chromosomes, which in their number, size, shape, and probably structure, are constant and characteristic for each species The chromosomes carry in some material form what are called the *genes*, and the *genes* in the germ-plasm control the appearance of definite characters in the offspring; it is believed they carry the hereditary factors This is new knowledge, discovered in comparatively recent years

In the text-book to which we have already referred, Haldane and Huxley remark "The latest advance in general biology has been the discovery that inheritance takes place by means of separable units, generally known as unit factors or *genes* It is effecting the same sort of revolution in our biological thinking that Dalton's realisation of atoms as the units composing chemical substances did for chemical thinking a hundred years ago"

Now let us turn back to the subject of Natural Selection As we have seen, natural selection can only act when it has variations to act on, *the variations originate in the germ plasm* (that part of the organism which is transmitted to its descendants in reproduction) What have biologists to say about *how* these spontaneous variations arise? How do mutations come about? How does the distinctly *new* arise? How did new species come into being?

Without any beating about the bush one has to say that such questions cannot yet be answered We must relegate them to the unsolved problems of biology The biologist will tell you that the cell may be justly regarded as the microcosmic unit of life, a little world Like man, it is fearfully and wonderfully made, it is only in the present generation that biologists have come to know what complex little worlds cells are In barest form, let us put it down in this way

The cell is a living thing with a life of its own

Each individual life begins as a fertilised cell

Fertilisation consists in the union of two cells

The two cells which unite are called *gametes* (marrying cells)

Both cells contain certain minute bodies called *chromosomes*

Each adult individual has two sets, or pairs, of chromosomes (one coming from the father, one from the mother)

In a human being the number of chromosomes in these two sets is forty-eight

The chromosomes contain the *genes*

The *genes* are the units which control the appearance of definite characters in the offspring They are called the *factors of heredity*

How Variations Originate

What follows on fertilisation is a very intricate affair and some patience is required of the student who would understand The science of Mendelism is a comparatively new science, and with the other individual sciences will come within our range in another section of this work Meanwhile we must try to indicate, shortly and generally, the answer that is given to the questions we have raised The problem is bound up with the *gametes*, or rather we should say with the *chromosomes* which contain the *genes*, or unit factors of heredity In fertilisation and subsequent development there comes about a great distribution or reshuffling of the unit factors, which we may liken to the reshuffling of a pack of cards, in the result the individual comes by its own particular inheritance Let us take a pack of cards, imagine the various cards being spontaneously shuffled and reshuffled, arranging themselves in combination and recombination in this tiny cell workshop, a cell which measures no more than $\frac{1}{125}$ of an inch in diameter—picture that and, roughly, you are looking on all these unit factors building up the hereditary nature of a new individual that is to be You will readily understand that there are great opportunities for many new and varied permutations and combinations in the chromosomes No two organisms are quite alike

As Professor Julian S Huxley says, all this machinery—and far more than we have indicated—can be seen through the microscope "The chromosomes have the property of staining very deeply with various dyes, and so being readily visible, and every stage of the process has been minutely described for many different animals"

The following passage from an essay on heredity by Professor Huxley may suggest the idea to the reader

To be brief we may say, first that all the

characters of a species are controlled in their development by definite units or factors, which can be handed on from parent to offspring Secondly, that all such factors are present in pairs, one being derived from the father, the other from the mother Thirdly, that when the reproductive cells are formed, the two members of a pair separate from each other, so that each sperm or each ovum must contain one member of a pair, but cannot contain both, and, finally, that different unit-factors are inherited independently of each other, so that, by making the right series of crosses, we can build up new races or varieties of animals by combining factors for characters of different existing breeds *All kinds of characters have been shown to be inherited by means of unit factors*

The answer to the question, then, How do variations or mutations originate? is that they are the result of the reshuffling of the units—unit factors contained in the chromosomes—and a recombination of them in new arrangements ***An alteration in the hereditary constitution is called a mutation***, and the biologist will tell you of many mutations that have been demonstrated in animals and plants Heredity is thus bound up with variation Every one knows that all living things vary That is to say, the different individuals of a species differ from each other It seems to be clear, that only through the fact of variation is evolution possible

Three Problems

But biologists are, so far, unable to solve three problems While mostly agreed that *chromosomes* carry the hereditary characters, the biologist does not know the nature of *genes* or units which control the appearance of definite characters Nor does he know the manner in which the *genes* influence development Nor, again, the way in which mutants of genes arise—in other words, *why* or *how* new characters arise All he does know is that the reshufflings we have described are actual occurrences

The germ cell is a living creature in a single-cell phase of being and it may be that its variations are the outcome of a primary quality of *living creatures, inherent in the germ-cell*—the capacity of making experiments in self expression It has been suggested that the changes in the germ cell which give rise to mutations are due to "*deeply saturating environmental* changes, such as a change of climate or in irradiation with gamma rays," or due to some other factors, but we need not pursue this problem further here One thing we may say biologists tell us that "*there is little usefulness in speaking of variations as 'fortuitous' unless we mean to emphasise the fact that they are usually unpredictable*, or unless we mean, as Darwin meant, that they are often the outcome of a complex of imperfectly known pre-conditions" *

§ 3

WE see, then, that new qualities and new characters, variations and mutations, are *due to the activities of the chromosomes in the* germ cells These variations are thrown up, we do not know how, when they are forthcoming, then natural selection steps in to take a hand in the game Some of the variations and mutations *survive and are perpetuated*, but not all—only those, as we have said, which favour the survival of the fittest for their environment become part and parcel of the inheritance of the race

We see how different, then, this modern cell theory and the theory of natural selection are from the Lamarckian theory of evolution, which attributes the process of evolution partly to environment, and partly to the use and disuse of bodily functions, that is to habits

And yet we cannot say that these new doctrines are proved up to the hilt, no one can prove, with *scientific certainty*, that natural selection *alone* is the one thing that explains the method of evolution There is no question as to the reality of evolution, but no theory that claims to explain the *origin* and nature of species is proven That mystery is not finally solved So, after all, we may briefly turn to what is called 'creative evolution" *It is not to be brushed aside as an* impossible theory As we have remarked, Henri Bergson published his famous and much discussed book *Creative Evolution* in 1907 Bergson holds that there is some original 'vital impulse' (his doctrine of *élan vital*) behind the evolutionary process

(To be continued on page 129)

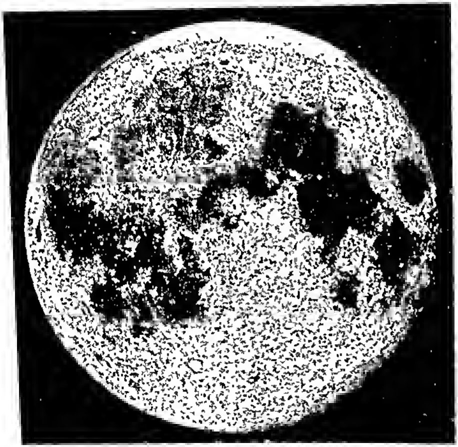
* Thomson and Geddes *Outlines of General Biology*

BOOK II—(*Continued from page* 44)

MODERN SCIENCE

CHAPTER III

ASTRONOMY—THE PLANETS—(*Continued*)



[*Photo: Baker*

MOON AFTER FULL PHASE

§ 1

THE MOON

THE moon is so very much nearer to us than any other heavenly body that we have a remarkable knowledge of it. In a sense, the largest telescope brings the moon to within fifty miles of us. There can be no doubt that the moon is a dead world. Seen through a telescope, it has all the appearance of a dead world; it has no water or water-vapour, and seems to have no atmosphere; if it ever had an atmosphere it has probably long ago lost it. The absence of atmosphere on the moon is partly responsible for the beautiful appearance it presents to the telescope. There are no twilight effects, and the shadows cast by the mountains and crater walls are exquisitely sharp. Even in a small telescope the characteristic lunar features start into view with extraordinary clearness. For the same reason the temperature changes on the moon must be very violent. An atmosphere acts both as a shield and as a blanket; during the lunar day-time its naked surface is exposed to the direct force of the sun's rays falling on it, and during the lunar night the accumulated heat is radiated unhindered into space, so that the variation of temperature is extreme, and far greater than anything known on earth.

And in the total absence of air and water and

THE MOUNTAINS OF THE MOON

From the photograph of a plaster model executed by Scriven Bolton F.R.A.S., from telescopic observations

Now through the passing, cloud she seems to stop
Now up the pure cerulean rides sublime
Wide the pale deluge floats and streaming mild
O'er the skied mountain to the shadowy vale
While rocks and floods reflect the quivering gleam
The whole air whitens with a boundless tide
Of silver radiance trembling round the world

The moon is interesting to us precisely because it is a dead world. It seems to show how our own earth or any such cooling globe, will develop in the remote future. We do not know if there was ever any life on the moon, but in any case, it cannot have proceeded far in development. At the *most*, we can imagine some strange lowly *forms of vegetation linger*ing here and there in pools *of heavy gas, expanding* during the blaze of the *sun's long day*, and *frozen* rigid during the long night.

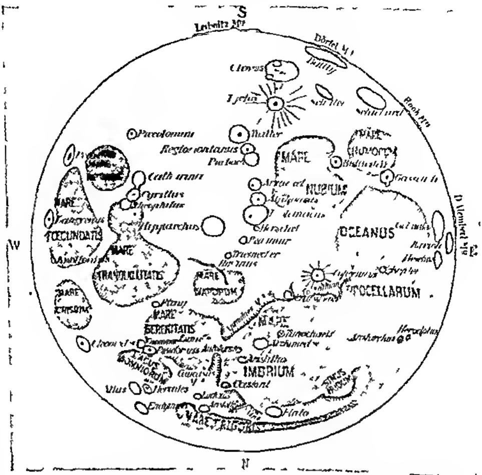
atmosphere, *there can be no sound on the moon* for sounds are merely air waves, nor any visible movement, no floating dust, no scent, no twilight or blue sky, no twinkling of the stars a changeless and eternally silent world.

A dead world—but for *us* a glorious spectacle. When the sun has sunk below the horizon, then the moon *is* the Queen of Night. We *have all* experienced the magic spell and the mysterious glamour of *moonlight—how it softens* and blots out the harsh outlines and detail of many objects that stand out *crude* and *bare in the glare* of sunlight. She throws over everything her silver mantle, the stillness of night enhancing the effect.

Origin of the Moon

Meanwhile, suppose we ask. *How* was she born? The moon is a satellite of the earth, and was born of the earth of which she once formed part—as our planet, the earth, was born of the sun of which it once formed part. The earth, on the tidal *theory*, as explained *elsewhere*, *originated as* the result of a tidal gravitational attraction of some star *passing* the sun and *drawing* out nebulous arms or filaments of matter *from* the gaseous sun; on these out drawn swirling gaseous masses there arose condensations or knots which detached formed the liquid or solid core of the future planets, among them

the earth. There is general agreement among astronomers about that, although not unanimous agreement. The other satellites of the planets, like the moon, must, it is supposed, have originated by some such type of process as had previously brought about the birth of their parents. A huge mass of molten matter was drawn from the parent globe and, whirling round rapidly, formed into the smaller globe which we call the moon. It starts on its independent career, becomes a satellite of the earth as the earth is a satellite of the sun.



A MAP OF THE CHIEF PLAINS AND CRATERS OF THE MOON

The plains were originally supposed to be seas hence the name "Mare."

Thus the moon accompanies the earth in its annual journey round the sun, just as the satellites of Jupiter and Saturn accompany these planets.

The moon makes a complete revolution round the earth in one month. As it rotates round its axis in the same period, it always presents the same face to us. It travels round the earth at a velocity of 2,270 miles an hour. As the moon is not self-luminous, but illuminated by the distant sun, as a thin crescent, when it is "young," only a small portion of the illuminated surface is turned towards the earth; when it is "full" the whole surface (turned towards us) is presented.

A Remarkable Spectacle

Looked at through a telescope the moon is a remarkable spectacle, and remarkable, too, the photographs we have of its surface, with every feature mapped out, as if it were a map of England instead of a photograph of the moon—its plains and craters, mountains and mountain ranges

There is nothing on the moon analogous to the gradual changes on the earth's surface produced by weathering, although the temperature changes may produce slight disturbances due to contraction and expansion. Nevertheless, slight variations of tint have been noticed in certain areas, and it has been suggested that these may be due to the growth and decay of some low form of vegetation brought into existence by water vapour or carbonic acid gas exuding from the interior through cracks in the neighbourhood.

The surface of the moon is a volcanic wilderness, airless and waterless. Seen through a telescope its surface is pitted with innumerable craters of various sizes. These craters consist of a circular wall surrounding a central depres-

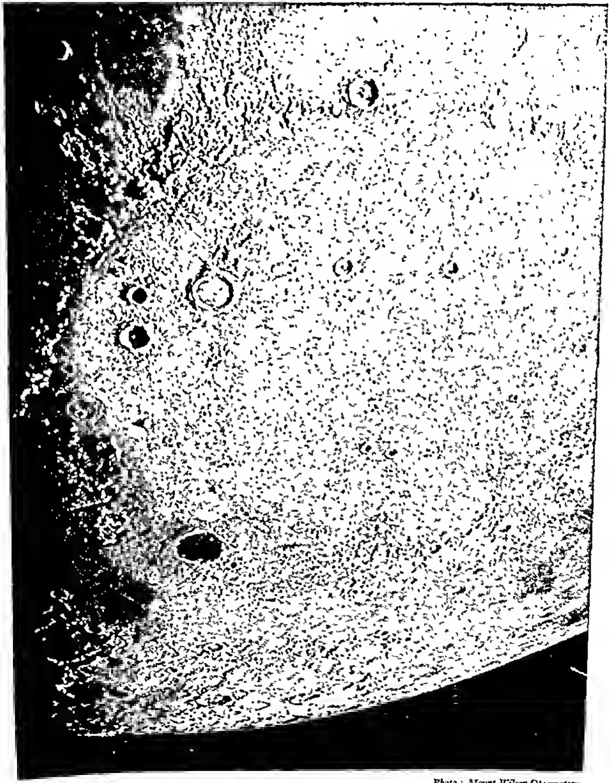


Photo: Mount Wilson Observatory

THE MOON

Showing a great plain and some typical craters, of which there are thousands.

of miles across The constitution of both is still mysterious The tail always points away from the sun, and would seem to be due to some repulsive power from the sun operating on the head of the comet

Now light itself exerts a pressure on anything on which it falls, and it may be the sun's light that is responsible for the tails of comets When a comet is advancing towards the sun its tail streams behind When a comet is receding from the sun its tail goes on before it But when the tails are studied more closely, it is found that this explanation does not work It is certain that something besides light pressure is involved, although light pressure may play a part At present no satisfactory explanation can be given of the formation of comets' tails We seem to be in the presence of forces new to us

Although the bulk of a comet is so enormous, its mass is very small This can be proved by noticing that a comet when passing near a planet, such as Mars, does not appreciably disturb it If it had a mass comparable to its size it would exert a very marked gravitational effect on any planet near which it passed We conclude that the earth is at least a million times heavier than the biggest comet This fact is sufficient to show that the head of a comet cannot be a vast solid body Many authorities consider that it is composed of a shoal of meteors, which are stony bodies of various sizes some being as small as a pea and some weighing a few tons There are vast swarms of these bodies journeying round the sun

A Remarkable Comet

The theory that the heads of comets are actually swarms of meteors is supported by the history of a certain remarkable comet known as Biela's Comet In the January of 1846 this comet was seen to divide up into two parts At its next appearance, in 1852, the division between the parts had greatly increased In 1858-59, when it was again due, it had disappeared Another appearance had been calculated for 1872, but the comet still refused to appear What did occur was a magnificent display of meteors, and it was found that the orbit of this stream of meteors was the same as the orbit of the vanished comet This fact certainly seems to indicate that the comet was, in whole or part composed of meteors But from what we know of the constitution of meteors and of the heads of comets it is doubtful whether the two can be identical We have to confess that the nature of comets still remains mysterious

CHAPTER IV

THE DEEPER PROBLEMS OF ASTRONOMY

§ 1

THE questions we have left over to deal with in this final chapter on astronomy are concerned with the evolution the life history, and the death of stars As Flammarion the distinguished French astronomer puts it in space there are both cradles and tombs In the heavens there are nebulous masses stars, and star systems in every stage of evolution young stars stars in their prime of life, and stars, dark and dead that have run their course

To refresh the reader's memory let us recall one or two things that have been said in previous chapters and first as to the ages of the stars" Plainly, all we know as to that is dependent on the calculations of astronomers Sir James Jeans tells us that the ages of the stars can be estimated from the impression that time has made upon them," just as we estimate the age of a tree from

of miles across The constitution of both is still mysterious The tail always points away from the sun, and would seem to be due to some repulsive power from the sun operating on the head of the comet

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When a meteor encounters our earth, the friction of its passage through our atmosphere is usually sufficient to vaporise it completely The meteor then becomes the brilliant object known as a "shooting star" Meteors enter our atmosphere at an average speed of about twenty five miles per second, and the friction produced at this speed is sufficient to raise the temperature of the meteor some thousands of degrees Occasionally a meteor, or a fragment of a meteor, finds its way to the surface of our earth These are the "meteorites" that may be seen in our museums

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a number of sub divisions of its stems, or of rings in its cross section " There are three principal methods of estimating the age of the stars, we shall not go into them in detail, for that would take us beyond our purpose, which is to keep clear of too many technical details

We have seen that it is generally believed that stars are born in nebulæ of the type of the great extra galactic nebulæ " in these nebulæ we are *watching* the birth of stars, the *transformation* of an inchoate mass of gas into an 'island universe' of stars " Whence, how, or when the nebulæ came is not known, but Jeans presents us with a table of reasoned calculations based on facts that are generally accepted, and he concludes " The above table suggests that the sun s age must almost certainly be between five and eight million million years, and in all probability between seven and eight " He adds ' Stars are like children in that their weights give a fairly good indication of their ages, although no doubt a good deal must be *allowed for individual* peculiarities " There would appear to be stars which are very much older, and others very much younger, than our sun, but the larger number appear to be of about the age of our sun

Vast Ages of Time

One is impressed by the slowness of astronomical events It seems that practically no great change has taken place in the heavenly bodies in recorded times When the earth was born the sun was very much the same as it is *now, and has remained in all essential respects* during the whole of the earth's existence For a time when it was not so we have to go back æons *before* the birth of the earth, to the time when the sun was one hundred times its present weight That weight, it is calculated, represents the limit it could *ever* have been to be the star it is

Professor Eddington thinks the age of the sun might be ten million million years, on the other hand, it might be much less, we have just given Sir James Jeans's estimate

How can we imagine such vast periods of time? How can we picture even one million million years? That would be five hundred times the past age of the earth if we reckon the age of the earth, as is probable, at 2,000 million years It is over three million times the total period that *man has existed on this planet* We may *represent* these times by an image taken from Sir James Jeans, that felicitous inventor of images " Take a postage stamp and stick it on a penny Now climb Cleopatra's Needle and lay the penny flat, postage stamp uppermost, on top of the obelisk The height of the whole structure may be taken *to represent* the *time that has elapsed since* the earth was born On this scale, the thickness of the penny and postage stamp together represents the time that man has lived on earth The thickness of the postage stamp represents the time he has been civilised, the thickness of the penny representing the time he lived in an uncivilised state Now stick another postage stamp on top of the first to represent the next five thousand years of civilisation, and keep sticking on postage stamps until you have a pile as high as Mont Blanc '

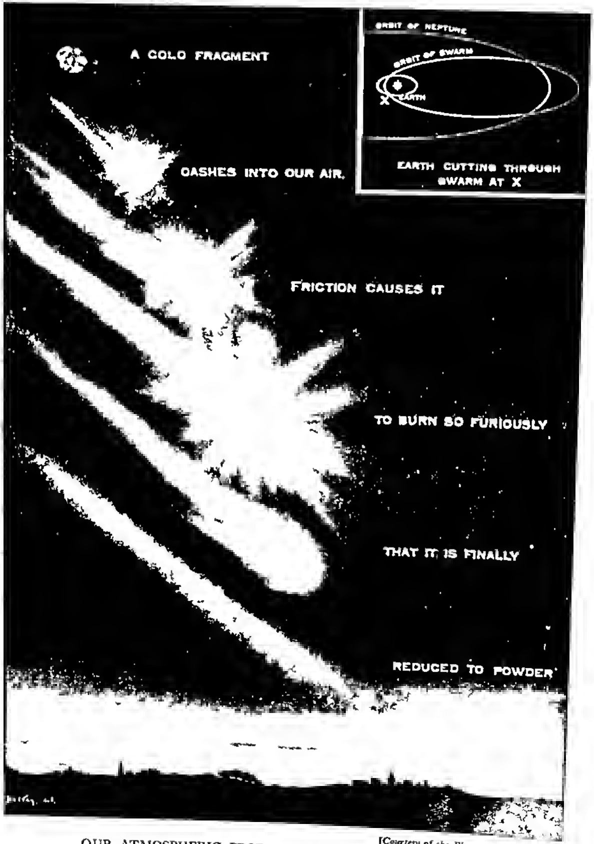
In this way we may arrive at an image of 1 000,000 million years, and see it in relation to the time during which man has existed According to various authorities we might put down the following figures

The sun has existed, say—
8 million million years
The earth has existed—
2 thousand million years
Age of life on earth—
3 hundred million years
Age of man on earth (?)—
300 thousand years
Civilised man has existed 10 thousand years

The Sun's Energy

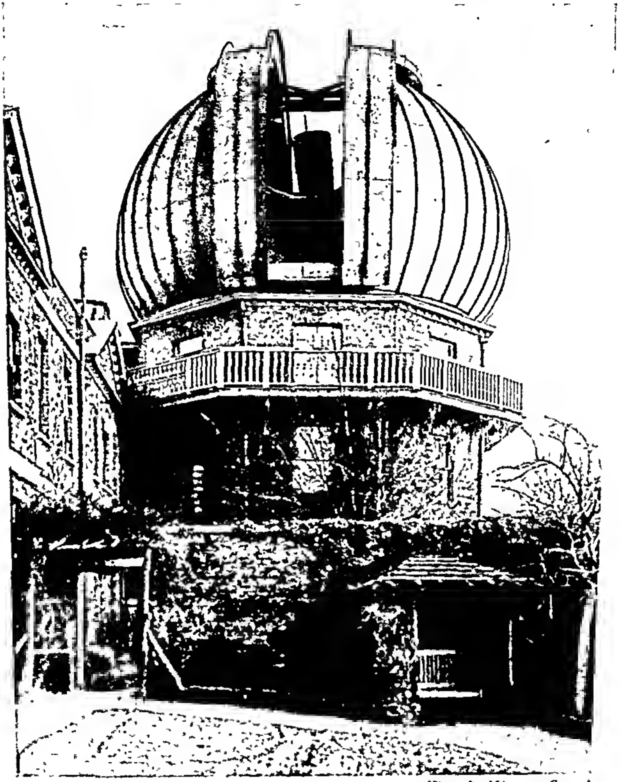
Inconceivable to our imagination as the astronomical time scale is, the stars are not eternal Neglecting the technical details of Sir A S Eddington's chapter on " The Age of Stars," in his book *Stars and Atoms*, we may quote the following paragraph

' Since we cannot well imagine an extraneous source of heat able to release itself at the centre of a star, the idea of a star picking up energy as it goes along seems to be definitely ruled out *It follows that the star contains hidden within*



[Courtesy of the Illustrated London News

OUR ATMOSPHERIC PROTECTION AGAINST METEORS



[Photo: Royal Observatory, Greenwich

THE DOME OF THE 28-INCH REFRACTOR, ROYAL OBSERVATORY, GREENWICH

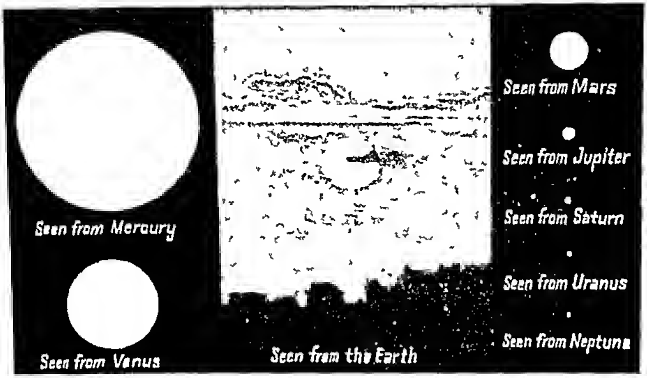
it the energy which has to last the rest of its life"

As we have seen, there are different methods of determining the ages of the stars, one is the contraction hypothesis That hypothesis supposes a fall of the matter towards the centre of the star, and heat, in this way, is made available as a result of the gravitational potential energy being converted into heat The contraction theory, for reasons we have already given, is not now accepted, if it was ever generally accepted, it is found to be 'hopelessly inadequate"

Another hypothesis, as we know, rests on the supposed annihilation of matter in the star's interior, and the consequent gradual radiation of the star's energy into space, the energy is released in the interior of the star That energy comes from the electrons and atomic nuclei, atoms are annihilated or broken down, and it may be that there is also a release of energy by a regrouping of the electrons and protons in the atomic nuclei, in other words, in the transmutation of elements In this way the transmutation of the elements is realised in the transformation of radio active substances, radio active substance being a substance whose atoms are breaking up

This hypothesis we have described has its difficulties Professor Eddington concludes "'There is considerable evidence that as a star grows older it gets rid of a large fraction of the matter which originally constituted it, and apparently this can only be contrived by the annihilation of the matter The evidence, however, is not very coherent, and I do not think we are in a position to come to a definite decision On the whole, the hypothesis of annihilation of matter seems the more promising"

Stated in a simple way by Jeans 'As a star ages those elements which are most short lived disappear first while the most permanent atoms survive the longest This is equivalent to saying that its most energetic generators of radiation disappear first, while the atoms which persist into the old age of the star are but feeble generators of radiation It follows that as a star ages, its average rate of generation of energy



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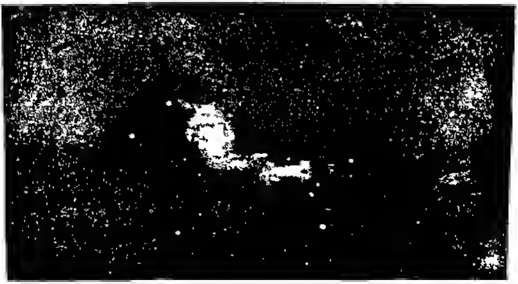
THE VARIATION IN THE APPARENT SIZE OF THE SUN AS SEEN FROM THE VARIOUS PLANETS OF THE SOLAR SYSTEM

[Mount Wilson Observatory

THE "HORSE'S HEAD" IN THE GREAT NEBULA IN ORION



[Mount Wilson Observatory

TWO NEBULÆ SUGGESTIVE OF TIDAL ACTION

(As Sir James Jeans says "they are very probably under one another's tidal influence.")

per unit mass decreases And, of course, since its radiation is produced at the expense of the matter it contains, its mass also decreases"

If we pursued this subject of stellar energy further we should have to consider the question of cosmic radiation, which is known to exist in space and which does not come from the *interior* of the stars It is suggested that this supposed cosmic radiation may be a source from which stellar energy is replenished But that theory has, as yet, no confirmation

§ 2

A Star's Life-Story

In his book *Stars and Atoms* Professor Eddington writes "Twenty years ago stellar evolution seemed to be very simple The stars begin by being very hot and gradually cool down until they go out On this view the temperature of a star indicated the stage of evolution that it had reached" He tells us that it is not so simple as that To-day it seems likely that "density would be a more direct criterion of evolutionary development than temperature" A star of high density is a star that has its atoms packed closely Its mass is in a relatively small volume The word "mass" means, of course, *the quantity of matter in a particular volume* A thing may change in size, or volume, that is, expand or contract, but the "mass," that is, the quantity of matter in it, may remain the same

There are stars of such density that a piece of lead compared with their substance would be like a cobweb In the youngest stage a star is very diffuse, condensing out of nebulous material, from that stage it contracts and steadily increases in density A star condenses to a stage where it is no longer a gas That is to say, its molecules no longer have perfect freedom of movement On the theory of atomic disintegration we have to imagine atoms stripped of their electrons, that is, atoms disintegrated, free electrons occupy very much less space than do integrated atoms

[Photo Yerkes Observatory

THE GREAT NEBULA IN ANDROMEDA

Let us take an illustration of a star's density A star like Betelgeux, one of the largest known, falls into the class of stars called "Giants" on account of their great size, they are exceedingly tenuous, or diffuse They are the very youngest

light and heat for millions of millions of years to come"

We must not suppose that more than a mere fraction of stellar radiation strikes the earth in the form of sunlight and starlight, or other forms All but an infinitesimal fraction of radiation wanders away into space, travelling ever onwards

Running down

"Ultimately a time must come when every atom which is capable of dissolving into radiation will have done so The universe is like a clock which is running down, a clock which, so far as science knows, no one ever winds up, which cannot wind itself up, and so must stop in time It is at present a partially wound-up clock, which must, at some time in the past, have been wound up in some manner unknown to us By studying the mechanism of the clock, and noting the length of spring which is still coiled up and the length already uncoiled, we can estimate the length of time the clock has still to run and the length of time since it was wound up, but we can obtain no evidence as to the way in which it was originally wound up and set going

"The universe cannot have originated by chance out of its present ingredients, and neither can it have been always the same as now For in either of these events no atoms would be left save such as are incapable of dissolving into radiation, there would be neither sunlight nor starlight, but only a cool glow of radiation uniformly diffused through space This is, indeed, so far as present day science can see, the final end towards which all creation moves, and at which it must, at long last, arrive' (Jeans)

A Star's Life-Story

In short, then, the life-story of a star is this Each star or sun is first, as a young star, very tenuous, and in its motion of rotation gradually condensing, it becomes a deep red colour It grows older, becomes much more dense, accompanied by a change of colour from red through yellow to white and blue With increasing age it is denser still, but now it is cooler It is now dark red It continues to shrink We are thinking in millions of years "As the ages pass away these tendencies continue, and the star steadily retraces its former sequence of colours, but more slowly and at a reduced rate of shrinking When it is approaching the yellow stage it is in the condition of our sun, and has been living for seven million million years, but it has by far the greater part of its life to come"

As density increases the star's atmosphere undergoes certain remarkable changes, which the astrophysicist will explain to you He will perhaps say "In the young suns the atmosphere consists of numerous lighter elements and compounds that can exist at relatively low temperatures, in the somewhat older suns—intensely hot—the atmosphere contains only the lightest and simplest atoms (such as hydrogen and helium), in the old red suns there are heavier elements and various compounds" He will startle you by explaining the amazing density of some of the aged suns He will tell you, for example, that a cupful of material from one of these old red suns if weighed on the surface of our earth would scale twenty five tons What we have to think of then is simply this in the course of its long, long life of millions of years a star goes through many vicissitudes

To recapitulate As a young star the sun was diffuse, an extremely rarefied mass of gas Then, blazing hotter than we can imagine, it goes on through æons of gradual change It shows increasing density, and therefore shrinks throughout its life, it loses mass and therefore luminosity, at length its temperature begins to fall "until at last the star degenerates into a cold, dark, dense body, and swims out of our ken altogether" Thus our sun is on the road to extinction By that time—say, a million million years hence—the human race will not be here to see it, unless human beings have adapted themselves to a temperature of about 30° C lower than now—"seas and rivers will be frozen packs of solid ice" Terrestrial packs of solid ice that will not glitter under the rays of our sun, for we left her a cold dark body swimming out of our ken Where has she gone? Has she passed down the "main sequence" belt of cooling stars and joined the band of "white dwarfs," so cold

as to become invisible? Shining, if they shine at all, only by reflected light?

The Final State

What are these white dwarfs, which are comparatively abundant in the stellar universe? One of them is known as the Companion of Sirius For a full account of the Companion of Sirius we must refer the reader to Professor Eddington's *Stars and Atoms* It is a star of incredible density We may quote a paragraph from the book mentioned ' We learn about the stars by receiving and interpreting the messages which their light brings to us The message of the Companion of Sirius when it was decoded ran 'I am composed of material three thousand times denser than anything you have ever come across, a ton of my material would be a little nugget that you could put in a match box' What reply can one make to such a message? The reply which most of us made in 1914 was, 'Shut up Don't talk nonsense''

But there is no "nonsense,' for since 1914 a theory to account for the state of the star has been worked out 'it pointed to the possibility that matter in the stars might be compressed to a density much transcending our terrestrial experience" So the message of the Companion of Sirius was no longer dismissed as nonsense, and it seems that matter at least two thousand times denser than platinum exists in the stellar universe

The white dwarf stars, then, represent the utmost limit of contraction, the great majority of their atoms are stripped bare right down to their nuclei, and therefore emit abnormally little radiation, the free electrons, no longer bound up in the atoms, are left and are immune from annihilation The white dwarf stage is the end of a star's life as a brilliant luminary, and, we are told, every star must necessarily end its career as a white dwarf It is "hot," but only in its interior, where its molecules are moving speedily, the surface temperature falls gradually to zero Says Eddington "Because the star is intensely hot it has enough energy to cool down if it wants to, because it is so intensely cold it has stopped radiating and no longer wants to grow any colder We have described what is believed to be the final state of the white dwarf and perhaps therefore of every star" A star that has reached that stage is invisible 'like atoms in the normal (lowest) state they give no light"

We have not discussed the whole story of white dwarfs, for there are stars that may begin as white dwarfs, but we must leave the story here

No Absolute Certainty

It remains to be said with respect to the theories we have been dealing with that there is at present no absolute certainty, the details are technical and difficult On the two problems of a star's energy and the change of mass which must occur if there is any evolution of faint stars to bright stars Eddington concludes "I have shown how these appear to meet in the hypothesis of annihilation of matter I do not hold this as a secure conclusion I hesitate even to advocate it as probable, because there are many details which seem to me to throw considerable doubt on it, and I have formed a strong impression that there must be some essential point which has not yet been grasped I simply tell it to you as the clue which at the moment we are trying to follow up—not knowing whether it is false scent or true"

The broad facts and the main principles of astronomy as we have outlined them here may be taken as well established, let us now turn to consider our own planet, the Earth

(To be continued on page 153)

LITTLE BIOGRAPHIES

I.

NICOLAS COPERNICUS

(1473–1543)

[R schgits

NICOLAS COPERNICUS

HE was the founder of modern Astronomy, and made the discovery of the earth's motion.

The idea that the earth might be a sphere round which the sun and other heavenly bodies revolved had been entertained in a vague way by one or two of the ancient Greek philosophers. The sun to them was a small thing compared with the earth; they had no idea of the magnitude of the sun. Most of the planets were known to them and they supposed the sun to be a planet.

Copernicus's observations and mathematical calculations led him to believe that the sun was not a planet, but the centre of a planetary system, and that the earth was not the centre, nor stationary, but revolved round the sun once a year. The sun and not the earth was the centre of our universe. Thus the Copernican scheme replaced the scheme of Ptolemy, which had held sway down to this time. The fundamental doctrines of the Ptolemaic system were that the *earth* was the centre of the universe, and that the heavenly bodies revolved round it, and at a uniform rate. The Ptolemaic system embodied other and more strange notions about the earth and other spheres.

As soon as astronomers came to understand and test the Copernican theory, the absurdities of the venerable Ptolemaic system, which had received the papal seal of infallibility and had ruled men's minds in some form for about twenty centuries, "crumbled to atoms and sunk into oblivion."

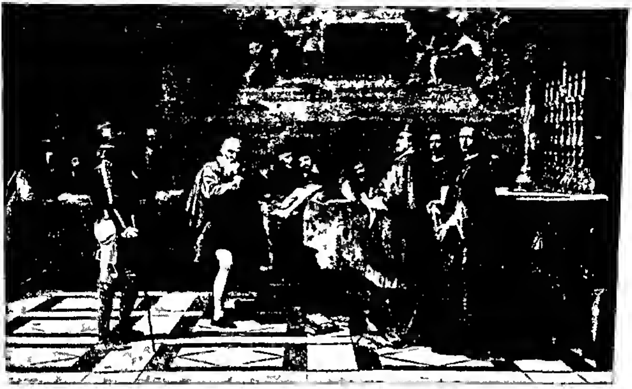
Copernicus was born in Poland in 1473. His views were received with favour by a few learned ecclesiastics, but in general with hostility, and regarded as impious; he was forbidden to teach his theory. His book on the revolution of the celestial bodies was published in 1543. For three centuries it remained on the index of forbidden and opprobrious works, from which it was not removed until 1822.

Copernicus himself, says Sir Oliver Lodge, "did not live to experience either the controversies or the rejections or the ultimate acceptance of his theory"; a copy of his book "was brought to him lying on his death bed with dim eyes so that he could hardly see it. He felt it, and left it to the world as his life work."

The Copernican theory effected a revolution in man's ideas about the universe. nobody had dreamed that the stars were so many and so far away and the sun what it is; to the people of Copernicus's day the discoveries seemed to degrade the earth thus lifted down from its high pinnacle and position of paramount importance.

Copernicus laid down broadly the lines of future work; astronomers reverence his name, although some of his ideas were faulty and wrong; a great deal was done later to improve on his work by men like Kepler, Galileo, and Newton. His great achievement was to shift the centre of the solar system from the earth to the sun; to explain the alternation of day and night by the earth's rotation round itself; and the order of the seasons by the earth's revolution round the sun.

Tycho Brahe (1546–1601), using instruments far more accurate than had been used before, worked out a system based on the discovery of Copernicus; and John Kepler (1571–1630), a pupil of Tycho Brahe, defined in mathematical terms the laws governing the orbits of the planets, thus finally establishing the truth of the Copernican theory.



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GALILEO BEFORE THE PAPAL TRIBUNAL

II

GALILEO

(1564–1642)

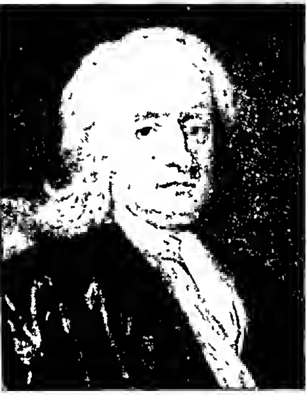
HE was the first to turn the telescope to astronomical uses he invented the first astronomical telescope, that magnified about thirty times, he set up an observatory at Padua, and discoveries came thick and fast He saw the mountains on the moon, the extinct volcanic craters and what he thought, wrongly, were seas (they are called by that name on maps still) Every one has seen the "old moon in the new moon's arms", it is the dark part of the moon not illuminated by the sun, Galileo explained this visibility of the dark part as earth light reflected back to the moon—evidence that the earth was like the other planets, and did shine All this evidence proved the Copernican system, which before had lacked confirmation

"He also saw spots on the sun, a thing which was very annoying to orthodox philosophers, since they had taught that heavenly bodies were free from all defects, and a great contrast to the earth" He observed the phases of Venus and thus proved the truth of Copernicus's theory that the earth was a planet He made many other observations and discoveries, including the satellites of Jupiter, again emphasising the resemblance of the earth to a planet

Everybody knows how Galileo was forced by the Inquisition to abjure his doctrines In spite of his old age and infirmities he was summoned before the Inquisition, and after a wearisome trial was sentenced to an indefinite term of imprisonment This was commuted by Pope Urban into permission to reside at Florence He was no enemy of the Church, and he suffered mental as well as physical pain "He was made to recant under the threat of torture and to perjure himself by denying the Copernican principles although he knew them to be true—an awful catastrophe for a scientific man, blaspheming against the whole *spirit of science, for its God is Truth* His recantation was broadcast and read at all the Universities At Florence, his home, it was read out in the cathedral church, all his friends and

adherents being specially summoned to hear it. This must have been ghastly mental torture; and thereafter he was forced to remain in seclusion, and more or less hold his peace" (Sir Oliver Lodge). Perhaps his biting satirical tongue was partly responsible for his troubles.

Galileo was one of the fathers of experimental science and invented scientific apparatus. For eighteen years he held the chair of mathematics at the university of Padua. It was Galileo who climbed the Leaning Tower of Pisa to prove, against all beliefs, that if he dropped together a ten-pound weight and a one-pound weight they would descend with equal velocity and reach the ground simultaneously. "It is not too much to say that Galileo started modern science on the course which has extended unbroken to our own day."



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SIR ISAAC NEWTON

"The greatest man of science who has ever lived"

III. SIR ISAAC NEWTON

ISAAC NEWTON (1642–1727) is, by general consent, the greatest man of science who has ever lived. His combination of mathematical power, insight into physical reality, and experimental ability, has never been equalled. The most famous of his achievements are his discovery of the Law of Gravitation, his discovery of the Composition of Light, and his invention of the Differential Calculus But besides these he made a whole host of other contributions to science of the very first quality and importance. The attitude of his contemporaries towards him is expressed in the well-known lines:

Nature, and Nature's laws, lay hid in Night.
God said, "Let Newton be!" and there was Light.

He was born at Woolsthorpe, a small hamlet in Lincolnshire, on Christmas Day, 1642. His father, who died before he was born, belonged to a family which had farmed the small Woolsthorpe estate for several generations, and, although not wealthy, they were not poor. At the age of twelve years Newton was sent to the King's School at Grantham. He did not, at first, show himself as a brilliant student, but after fighting and defeating a boy who had bullied him, he completed his revenge by surpassing him in his studies, and became top boy of the school. In his private life he drew, composed verses, fashioned a variety of mechanical contrivances, and constructed sundials. His mother at first destined him to a farming career, but his complete indifference to that pursuit soon became so marked that she was persuaded to send him to Cambridge to continue his studies.

Newton entered Cambridge University at the age of nineteen with no definite plan of study. It seems to have been quite accidentally, through picking up, at a local fair, a book on astrology of which he did not understand the mathematical terms, that he was led to the study of mathematics. His progress, once he began, was amazingly rapid, and by the age of twenty-three he had thought out the principles of his theory of gravitation, of the differential calculus, and of his theory of light. These unexampled achievements he simply kept to himself. A certain secretiveness, a dislike of publicity, an indiffer-

ence to fame were characteristic of Newton all his life But his general attitude was even more singular than this would indicate He seems to have been largely indifferent even to science itself, and to his own unparalleled genius Some of his references to mathematics betray a queer contempt for that activity, and he abandoned the study of science for years in order to devote himself to theological and mystical speculations At the end of his life he likened himself to one who had been engaged in picking up pretty pebbles on the beach while the great ocean of truth lay all unexplored before him, and this was not an insincere poetic flight, but a genuine estimate of his achievements Newton was, in fact, overwhelmingly impressed by the fundamental mystery of the universe

Newton became professor at Cambridge at the age of twenty six and lectured for the most part, on his researches in optics and algebra His theory of gravitation he left in abeyance for many years, and it was only upon the express solicitations of some of his contemporaries that he went thoroughly into the matter The result was the greatest of all scientific treatises the *Philosophiæ Naturalis Principia Mathematica* (the Mathematical Principles of Natural Philosophy), published in 1687 This is the greatest of Newton's achievements Laplace said that it is pre eminent amongst all the productions of the human mind, and Lagrange said that he felt dazed at this exhibition of what the human mind is capable of With this work, in its immense scope and masterly perfection, Newton became, as Laplace said, the "legislator of the universe" The Newtonian outlook, as expressed in this work, has, indeed, endured for over two centuries, and has only been replaced in our own time by Einstein's Theory of Relativity

A few years after this the King saw fit to honour Newton by appointing him Master of the Mint, a position whose duties Newton took very seriously, with the result that he did no more important original work in science until the day of his death—a period of thirty-one years Yet Newton had lost none of his power "Challenge problems," sent him by Continental mathematicians were solved with the same old easy mastery He died in his eighty fifth year, on March 20, 1727, and after lying in state in the Jerusalem Chamber, was buried in Westminster Abbey

LAPLACE

One of the greatest mathematical astronomers of all time and originator of the nebular theory It was a plausible hypothesis and survived for a century but accumulated criticism has led to its being abandoned

J C ADAMS

He made one of the most dramatic discoveries in the history of astronomy By a mathematical calculation he predicted the existence of an unknown planet And Neptune was discovered where he said it ought to be

BOOK III—(*Continued from page 64*)

THE DEVELOPMENT OF RELIGIOUS THOUGHT AND MODERN DISCOVERY

CHAPTER I—(*continued*)

THE THREE KINGS

§ 1

SAUL, DAVID, SOLOMON

JOSHUA being dead and things going badly under their local leaders or Judges, the Israelites demand a king of their own The last of the Judges was Samuel near the end of his rule (there had been a succession of failures and disasters) the *people refused to obey the voice of Samuel* " We will have a King to rule over us, that we also may be like all the nations, and that our King may judge over us, and go before us, and fight our battles "

Painting by Matteo Ro ll] THE TRIUMPH OF DAVID [*Mansell*

And David took the head of the Philistine and brought it to Jerusalem (I Samuel xvi)

The Story of Saul

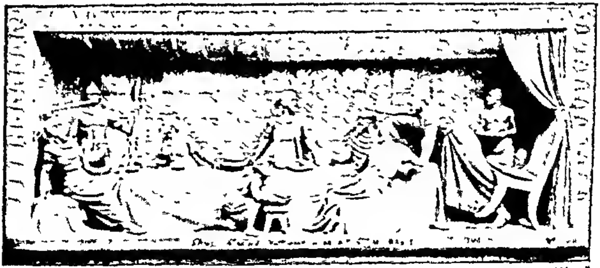
Saul thus became the first King of Israel. He showed great prowess and waged almost continuous warfare. He tried to free the land the Israelites held from the yoke of the Philistines. He had successes and he had defeats, and vexations began to cloud his mind with a deep melancholy or mania. He dies after his defeat at Mount Gilboa, slain by his own hand He failed to consolidate a kingdom; his reign is full of jealousies, strife, and animosities. His jealousy of the young warrior David, who now comes into the picture, his attempt to kill him, and David's flight and exile is one of the most dramatic stories in the Bible. The fury of Saul against David, and his accumulating troubles, drove him insane; he is a pathetic figure. We need not retell the story fully.

King David

We have now arrived at about 1,000 years before the Christian era. David comes to the front, "a mighty man of valour and a man of war." His career is a great drama We hear of him first as a shepherd boy, tending the sheep of his father Jesse on the hills, he had some fame as a skilful harp player, which led to his being brought to the court to soothe Saul's morbid melancholy By and by he acquires more fame as a young warrior and Saul's jealousy is aroused He is driven into exile, outlawed and hunted by Saul in the Judean hills; we hear of him raiding and plundering, fighting heroically, now here, now there, with his band of kindred spirits. "Robbing the rich for the poor, he was Robin Hood; whipping the mighty against odds, he was Bruce; winning the friendship of Jonathan, he was Damon He played exquisitely, he fought heroically, he loved titanically. Withal he was a profoundly simple being, cheerful, despondent, selfish, generous, sinning one moment, repenting the next, the most human character of the Bible" (Dr. Sachar). To this young, tempestuous, gallant freebooter kingship of all Israel seemed remote. But to that he came.

He proved himself a great warrior, a great general and organiser, and a supreme ruler of his people, and a just administrator, a strong man, and a hero; one of the greatest geniuses in Biblical history. During his exploits as a fighting warrior, extending over many years, he subdued the Philistines, with his "Mighty Men" he defeated the Moabites, the Ammonites, and the Edomites He captured Jerusalem and made that city the capital, and he laid the foundation of the Israelite empire.

The Old Testament deals very plainly with David If he was a man "after God's own heart" it was not in the sense that he was a



From a [illegible] by George Tinworth [illegible]

SAUL HURLING THE JAVELIN AT DAVID

In this incident Saul first displayed the jealousy which was to drive David into exile

saint, but because he was a heroic warrior-king, who possessed the necessary worldly qualities for a ruler of God's people. The Bible does not treat David's sins lightly. He was guilty of many private wrongs, and the outraged sense of the people was expressed through the mouth of Nathan the prophet, who boldly reproved him for the shameful affair with Bath-Sheba. Often he practised deceit, and several of his foreign wars were marked by great cruelty, and there were acts of deception and cunning. But he founded the Israelite kingdom. And more: "David perceived that the spirit of his nation and its destiny only worked in the close connection of the national with the religious life. He had an eye for the most secret inner existence of his nation, according to which it must be the people of religion, God's people. Thus he becomes at once the historical, and what was inseparable from this, the religious hero of Israel. . . . Jerusalem the royal city is at the same time the city of God, the holy city; David's dynasty is Jehovah's royal house" (Dr. Sachar). Before he died his prestige had sunk low. He had ceased to be his old self. His moral life proved an evil example and his declining days were marked by plots and counter-plots.

DAVID [Photo Anderson

The shepherd boy who became the greatest of the Hebrew kings

(The head shown here is reproduced from the full length figure sculptured by Michael Angelo and preserved in Florence)

The point to note is that Israel has now become an extensive political kingdom.

Solomon

King David dead, Solomon reigned in his stead (about 960 B.C.); "the beginning of his reign is as bloody as his father's . . . he proceeds to murder his brother, who has sought the throne, but quailed and made submission. He then deals freely with his brother's party." In the story of Solomon it is difficult to disentangle fact from legend. In Jewish and Mohammedan literature he is the wisest of men, a man also gifted with the power to control the spirits of the invisible world. In the Book of Kings we are told that "God gave Solomon wisdom and understanding exceeding much, and largeness of heart, even as the sand that is on the sea-shore." His fame was spread abroad through all the nations, and "from all people and all kings of the earth men came to hear the wisdom of Solomon." The plain truth would seem to be that Solomon simply had a remarkable and varied intelligence. His wisdom was not of that order inculcated by great religious teachers, prophets, and apostles; his wisdom does not represent piety, the fear and love of God. These virtues were not a predominant feature in the life of Solomon. "He had talked wisdom and practised folly." He was the worldliest if also the wisest of mankind.

Israel is extending her bounds, but her domestic affairs threaten trouble Professor DE Burgh describes the position "Solomon opened the door to foreign trade and fostered dynastic alliances with foreign courts, a policy which led to innovations in time-honoured social customs and to the introduction of foreign worship Wealth and luxury brought in their train class distinctions and a growing cleavage between rich and poor, forced labour was required for the building of king's palaces, fortified towns, religious sanctuaries, a court, a harem, and a swarm of military and priestly officials became part of the new order of life" *

Solomon possessed exceptional qualities of mind, comprehensive and many sided, sure discernment, quick judgment, and practical sagacity, an able judge, and an exceptionally cultured man in many directions for the time in which he lived Under his government the kingdom reached its apex of political glory, even magnificence, and he established a record in one respect there is no historical counterpart to his harem of a thousand wives and concubines a figure, of course, which is not to be taken literally ' But King Solomon loved many strange women (together with the daughter of Pharaoh), women of the Moabites Ammonites, Edomites, Zidonians, and Hittites He had seven hundred wives, princesses, and three hundred concubines, and his wives turned away his heart" (I Kings xi)

This seraglio does not altogether imply moral reproach these were the days of polygamy, yet he exceeded the bounds of decency and he was forbidden to multiply wives to himself, and reproached for taking them from among heathen nations, they drove him to idolatry, for he sacrificed to the national gods of his favourite wives *from heathen lands* This was the mark of his apostasy "Neither Solomon's establishment of the worship of Jehovah in Jerusalem, nor his vision of and conversation with his God at the opening of his reign, stood in the way of his developing a sort of theological flirtatiousness in his declining years He married widely, if only for reasons of state and splendour, and he entertained his numerous wives by sacrificing to their national deities, to the Sidonian goddess Ashtaroth (Ishtar), to Chemosh (a Moabitish god), to Moloch, and so forth The Bible account of Solomon does, in fact, show us a King and a confused people, both superstitious and mentally unstable, in no way more religious than any other people of the surrounding world" (Wells *Outline of History*)

Solomon's passion for building palaces and temples, fortresses, cities, gardens, and summer retreats, and his enormous extravagances embarrassed his country's resources, for he levied impossible tributes on his people It is not surprising that both in the Book of Kings and Chronicles, when his death is recorded, notwithstanding all the glory he had gained he received no word of commendation All that is said is that 'he slept with his fathers and was buried in the city of David, his father, and Rehoboam, his son, reigned in his stead"

The Kingdom Split in Twain

David had ruled an extensive Hebrew kingdom Under his extravagant son, Solomon, the Hebrew nation was rent in twain before it was a century old The excesses of Solomon had brought the Hebrews as a united nation to an end *Henceforth there are two Hebrew kingdoms, Israel in the north and Judea in the south*

So far this short summary has covered the history of the Hebrews for over 1,000 years—from Abraham to Moses 750 years, and from Moses and the Exodus to the last of the three kings about 300 years—Solomon died about 933 B C

Slowly and painfully progressing from the rude stage of nomadic scattered clans wandering in the desert, entering Palestine tribe by tribe, meeting opposition and enemies, they unite from time to time for the common purpose of both defence and conquest Finally they become a strong and united nation under David The result of Solomon's reign we have just seen

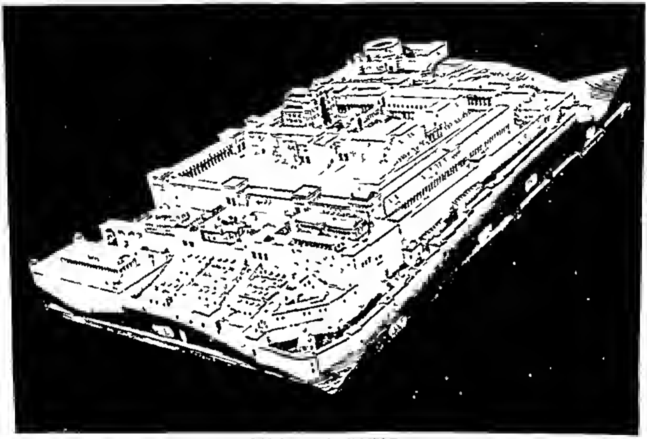
* *The Legacy of the Ancient World* Professor DE Burgh

§ 2

The Priests and Prophets

WE have been speaking about the rise of the Hebrew nation politically. We may pause in this narrative for a moment to say a word about the part played by the priests and prophets. All through the period we have been tracing the priests played a prominent part. The priesthood worked a wonder, turning his rod, we are told, into a serpent; he also brought the Egyptian plagues to pass by means of his rod; in the desert wanderings it was the miraculous budding of the rod of Aaron that silenced the murmurings and complaints of the children of Israel.

There are no traces in the Old Testament of ecstatic conditions on the part of the priests, but one of their chief functions in the earlier history



SOLOMON'S TEMPLE

Solomon had a passion for building temples and palaces, and his enormous extravagances embarrassed his country's resources

was, of course, no monopoly of the Hebrews Priestcraft and priesthood are almost as old as man; they play a dominating rôle in Egyptian, Assyrian, and Babylonian history, and in other countries. The Israelitish priesthood was instituted by Moses himself, and Aaron, as colleague or representative of the great leader and lawgiver, is in particular the head of the Israelitish priesthood. Aaron was the spokesman of Moses to Pharaoh, and it was before Pharaoh that he of Israel was the giving of oracles by means of the lot. The priest of the Mosaic law stood in the position of a mediator between Yahweh and the people, and his duty also was to instruct the people and direct their religious life Some were both priests and prophets, and prophets like Samuel, Nathan, Elijah, and Elisha directly interfered in the government of the state; we find the three kings, Saul, David, and Solomon, being frequently reproved for their transgressions

and for their self-indulgence The later prophets are in a different category and will demand our attention later

Prophecy

In Professor A B Davidson's interesting essay on this subject in *The Dictionary of the Bible*, he says "Hebrew prophecy, though the deepest movement of the human spirit and in many ways the most mysterious, has, like other movements of the spirit, a history There is the period of its obscure beginnings, the period of its highest purity and loftiest achievements, and the period of its decline and expiry, when its work being accomplished other agencies in the education of mankind took its place"

The origin of prophecy belongs to an early period in the history of the human race and it existed among all peoples

It originated from beliefs or feelings common to men everywhere, such as (1) that there was a supernatural a god or gods, on whose will and power the well-being and the destiny of men depended, (2) that these supernatural powers had communion with men and gave them intimations of their will and their purposes, and (3) that these intimations were not given to men indiscriminately, but to certain favoured men, who communicated them to others Having these beliefs, ordinary men or states desirous of living or acting in accordance with the mind of the deity, and particularly when in perplexity in regard to what lay in the future had recourse to those through whom the deity spoke, and consulted them

The supernatural powers it was supposed, gave intimation of their will and disposition towards men in two ways (1) in an external way, by objective signs or *omens* in the region of nature, as by the flight or cry of birds These creatures coming from heaven were the bearers of a message from heaven Other creatures also were the means of significant indications from the deity, for example, in the way they met a man, or the side, the right or the left, from which they crossed before him In all countries the sacrificial victim offered to the gods was held to exhibit signs from them, particularly in the convulsive movements of the liver and entrails of the freshly slain creature Less commonly omens were observed outside the animal world, *e.g* in the rustling of the leaves of trees In the East the movements and conjunctions of the stars were regarded as prophetic, though in this case the influence on man's destiny may have been supposed to be exerted by the stars themselves, which, however, were often identified with deities

(2) Besides this external or objective revelation, there was an inward revelation given in the mind of man In this case the deity possessed the man, inspired him, and spoke through him It is possible, indeed, that the animal omens may have sometimes been regarded as forms assumed by the deity or as possessed by him And from the curious feelings of antiquity regarding the *rapport* existing between animals and men, the animals may sometimes have been supposed to come to men not as messengers of the deity, but on their own impulse, knowing themselves what they told to men

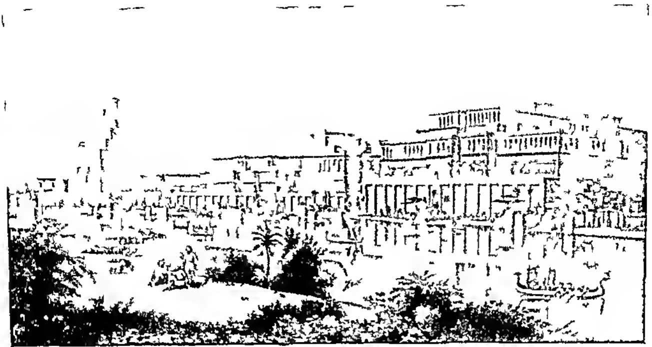
But this if true, belongs to a different circle of ideas Examples of this second kind of revelation are common in the heathen world as the Pythia in Greece the *kahin* in Arabia the sibyl, and the like Even in Greece this inward inspiration was considered something higher than divination by omens, and in ancient times, at least, the Oracle subserved high ethical and national ends The divine omens were not intelligible to ordinary men, hence they required persons either of special endowment or of skill acquired from tradition or by practice to interpret them Such persons, augurs soothsayers, diviners, or prognosticators, might be called prophets of the deity to men The Pythia being wholly overpowered by the deity, uttered her oracles with no consciousness of their meaning The oracles were often enigmatic, requiring an interpreter The interpreter was called *prophet* *

A National Movement

When we come to consider the pagan religion of ancient Greece we shall see what part oracles played in that country, about the same time

In the time of the Judges, as we saw on an earlier page, prophecy was rare, it came later. At that time inquiry of Yahweh was made by means of the ephod In the time of Samuel men called "prophets" were plentiful, existed in fact in great numbers, some were both priest and prophet Their "prophesying" was a kind of public worship at the high place or sanctuary, to which they went up with pipe and song Prophecy was a national religious move-

* Hastings *Dictionary of the Bible*



LAYARD S RECONSTRUCTION OF ASSYRIAN PALACES AND OTHER BUILDINGS

They stood on ra sed platforms on the banks of the Tigris about the 13th or 12th centuries B C when the power of Assyr a was at its greatest he ght

ment We have to remember that in Israel of th s age the national and the religious were virtually the same thing Hebrew prophecy was founded on the idea of national success But the later prophets like Hosea Isaiah and their successors have a new and higher conception They reiterated that Yahweh was a name for the one true God they proclaimed to the people that temporal defeat implied that they had not fulfilled their part of the bargain which was righteous living

The Messianic Idea

These later prophets laid no stress on the formal rites of sacrifice, they exalted the virtues of justice and righteousness and of a contrite and humble spirit Therein lay their hope this idea began to burn through the dark covering of merely patriotic re igion defeat could become an earnest of ultimate hope instead of ultimate despair for out of defeat could and did emerge the Messianic idea The doctrine of the Messiah the Anointed One grew under the force of adverse fortune out of the primitive notions common to *so many early civilisations of a holy priest king*

But we are anticipating what belongs to a later part of our narrative

§ 3

The Two Kingdoms

TO continue our historical narrative as we have said the excesses of Solomon had brought the Hebrews as a united nation to an end in 930 B C There are now two Hebrew kingdoms —in the north Israel rich and prosperous in the south Judah poor and weak besides Jerusalem she had no large towns many of the people continued to wander with their flocks

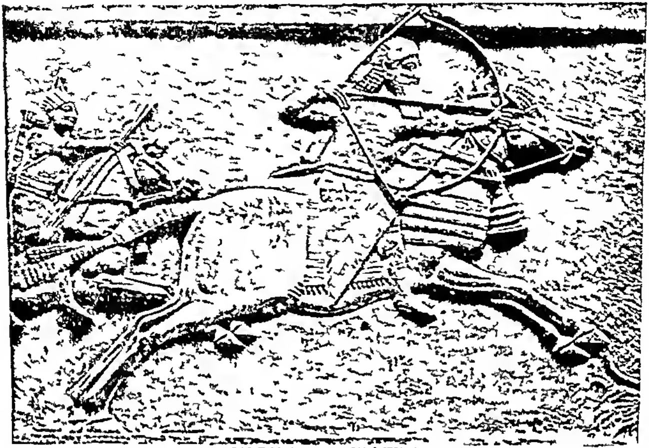
Here the following picture from Breasted is interesting

> These two methods of life came into conflict in many ways but especially in rel gion Every old Canaanite town had for centuries its local town god called its baal or lord The Hebrew townsmen found it very natural to worsh p the gods of their neighbours the Canaanite townsmen They were thus unfaithful to their old Hebrew God Yahweh (or Jehovah) To some devout Hebrews therefore and especially to those in the south the Canaanite gods seemed to be the pro tectors of the wealthy class in the towns with their luxury and injustice to the poor while Yahweh appeared as the guardian of the simpler shepherd life of the desert and therefore the protector of the poor and needy
>
> There was growing reason for such beliefs

JUDITH AND HOLOFERNES *Alinari*

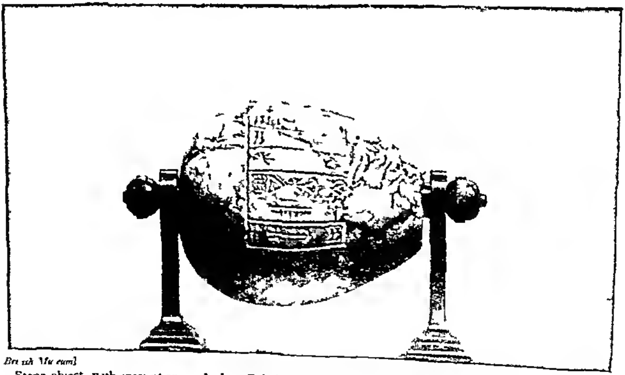
After the painting by Botticelli

The literature of the Hebrews was more extensive than is supposed and much of it was lost in the disasters that befell the nation. Not all of this literature was religious in character. The finely told tale of Judith and Holofernes, the theme of which is a beautiful woman's treachery in the cause of nationalism, may be read in the Apocrypha. She is seen in the picture returning with the head of Holofernes whom she had slain.



British Museum] SARDANAPALUS HUNTING [Mansell

Sardanapalus was the most scholarly of the great line of Assyrian Monarchs



British Museum] [Mansell

Stone object with inscription in Archaic Babylonian characters dedicated to the Sun god in Sippara by Sargon King of Accade about B.C. 3800

far more than a war god of the desert The simple shepherd could not resist the inner impulse to journey to the northern kingdom and to proclaim to the luxurious townsmen there the evils of their manner of life

We can imagine the surprise of the prosperous northern Hebrews as they suddenly met this rude shepherd figure clad in sheepskin, standing at a street corner addressing a crowd of townsmen He was denouncing their showy clothes, fine houses, beautiful furniture, and above all, their corrupt lives and hard heartedness toward the poor, whose lands they seized for debt and whose labour they gained by enslaving their fellow Hebrews These things had been unknown in the desert By such addresses Amos, of course, endangered his life, but he thus became the first social reformer in Asia We apply the term ' prophet ' to such great Hebrew leaders who pointed out the way to unselfish living, brotherly kindness, and a higher type of religion The same kind of effort to lead men to show justice and kindness toward all, especially to the poor, had long been known in Egypt, and it is possible that Amos had heard of such Egyptian teachings

Fearing that his teachings might be lost if they remained merely spoken words Amos finally sat down and put his sermons into writing and thus they have survived to us.

Assyria is in the ascendant, sweeping on in her conquests With Sennacherib and the coming siege of Jerusalem the crisis for Judah came As Byron sang, "The Assyrian came down like the wolf on the fold, and his cohorts were gleaming in purple and gold" Sennacherib is marching on Jerusalem The siege is an historic one, no one has pictured it more graphically than the sublime Isaiah Any one may read it in the Book of Isaiah The princely prophet in one great oration after another addressed the fear stricken, terrified multitudes which filled the streets of Jerusalem In all his passionate might and fervour Isaiah proclaimed undauntedly that the Assyrians would fail, that they would meet disaster He prophesied a great and glorious future for the Hebrews He roused the rulers of Judah from their policy of bickering, hesitation, and temporising, and his great, inspired eloquence was turned to influence public opinion He taunted the people for their folly in trusting in Egypt, for seeking to strengthen themselves "in the strength of Pharaoh," vain "to trust in the shadow of Egypt" Egypt is "the broken reed" He prophesies the fall of Assyria

ISAIAH [Anderson

JEREMIAH [Anderson

laughed thee to scorn, the daughter of Jerusalem hath shaken her head at thee The King of Assyria, he shall not come into this city, nor shoot an arrow there By the way he came, by the same shall he return'

So prophesied Isaiah, and his predictions were literally fulfilled Alone among the panic stricken inhabitants of Jerusalem there was a man whose heart never quailed' writes Mr W

[Anderson

EZIEKEL

L Courtney He was like Gordon in Khartoum Dr Whitehouse compared him also to Havelock in Lucknow Think what the issues were Outside the walls lay the unconquered densely served ranks of the Assyrians Inside were doubts despair the reproaches perhaps of Isaiah s enemy Shebna the scribe the vacillations of Hezekiah The fate of David s ancestral throne of Yahweh s chosen city seemed to hang in the balance suspended by a single thread over a gaping chasm Yet the prophet s soul is calm untroubled dauntless secure He bids without an accent of fear or doubt both king and people have faith in the God of their

fathers, Immanuel, the Lord with us This is the sublimest point in Isaiah's career, the triumph of his religious and statesmanlike policy The prophet had a reward which does not often happen to men of his vocation—his predictions were forthwith realised "

For the Book says, "Then the Angel of the Lord went forth, and smote in the camp of the Assyrians, a hundred and four score and five thousand; and when they arose early in the morning, behold, they were all dead corpses " Byron picturesquely sang ·

For the Angel of Death spread his wings on the blast,
And breathed in the face of the foe as he pass'd
And the eyes of the sleepers wax'd deadly and chill,
And their hearts but once heaved and for ever grew still

Or as the historian, *Professor* Breasted, says in more sober language "A pestilence from the marshes of the eastern Nile delta swept away the army of Sennacherib and saved Jerusalem, it seemed to the Hebrews the destroying angel of *Yahweh who had smitten the Assyrian host* Some of the Hebrews then began to see that they must think of Yahweh as ruling a larger world than Palestine "

After Judah's deliverance from the Assyrian Sennacherib, *nearly* a *century* passed *during* which Assyria was all-powerful, marching, as it seemed, to world supremacy The little vassal state of Judah paying tribute was left in peace But the respite was short-lived, for the Assyrian empire came crashing to the ground before her great rival the Chaldeans, who in turn began to attain world supremacy In the downfall of Assyria, Judah welcomed what she imagined was her deliverance from foreign oppression mission Their sufferings, extending over a year and a half, were dreadful This siege (586 B C) is one of the great horrors of history. The city was utterly destroyed and the temple razed to the ground All the Hebrew people "except the poorest of the poor" were carried off to exile in Babylonia

Thus was the Hebrew nation, north and south, wiped out It had existed but a short four and a half centuries The Hebrew race, however, was to live on; it lives to this day The Hebrew conscience had become *a living thing* *It was a* conscience created by the later Prophets, and we have said little about them The later prophets are not to be identified with the earlier seers and soothsayers, so-called prophets, mostly quacks and *ecstatic* dervishes, nor with the *time-serving* and often rascally priests

§ 4

The Great Prophets

FOR three centuries the great prophets succeeded *one another in startling uniqueness* They first arose during the monarchy "Out of the mire of Hebrew political life the prophets rose like strange exotic blossoms Their work is as surely the contribution of ancient Israel, as Hellenic art is the Greek contribution, and Imperial law and government the Roman Extraordinarily complex spirits they were, supreme individualists, yet preaching restraint and conformity to law, intensely *patriotic*, yet upbraiding the nation and threatening it with destruction, innately religious, yet despising the forms that religion took They were the

the rich revelled in luxury and sensuality, the poor were oppressed The strength of the nation had been the free peasantry, that was gone Against all this, and in protest, arises the lofty figure of Amos, of whom we have spoken, followed by Hosea at the time of the Assyrian menace, the sublime Isaiah, the profoundest and greatest of all, battling through fifty years of statesmanship in defence of Jerusalem, calling the doubting, transgressing, and sinful people to repentance, prophesying a great and glorious future for the Hebrews, thundering defiance to the hosts of Sennacherib, clothing his exhortations to his nation in language of lyrical splendour and immortal poetry, "a mystic seeking personal communion with God" At the same time Isaiah is intensely practical He had political prescience, and was a recognised adviser of the King of Judah He was against all international entanglements, and it was he who saved Jerusalem from Sennacherib He prophesied Jehovah's judgment on the nation for their national sin, no less he proclaimed Israel's ultimate restoration as a chosen and consecrated people "When the fall came at the hands of Babylon, Isaiah's message had taken root Already in his lifetime a faithful remnant gathered round him and formed the nucleus of a religious community within and distinct from the nation In this band of disciples the prophet saw the promise of an eventual restoration, after Jehovah had visited his judgment on the existing state, of a purified Zion, under a prince of the old Davidic line and with a sovereignty over the surrounding peoples, of an Israel made holy by suffering and living its national life in perfect accordance with Jehovah's law 'Therefore, saith the Lord the Lord of hosts, the Mighty One of Israel, Ah, I will ease me of my adversaries and avenge me of mine enemies, and I will turn my hand upon thee, and thoroughly purge away any dross, and will take away all thy sin, and I will restore thy judges as at first, and thy counsellors at the beginning, afterward thou shalt be called the city of righteousness, the faithful city' The note of hope had been sounded, and henceforward the faith in a restoration of Israel persisted with ever growing intensity as an essential feature in Hebrew prophecy" *

Jeremiah

There followed Micah, who, as someone said, gave us perhaps the finest summary of religious duty in any language "What doth the Lord require of thee, but to do justly, to love mercy, and to walk humbly with God?" And there came solitary Jeremiah, despondent over Israel's backsliding, and despising external rites and ceremonies, he taught the people that each must regard his own heart as the temple of Yahweh He prophesied the destruction of Jerusalem because of the wickedness of the people And he saw Jerusalem destroyed He was derided by the priests, denounced by patriots, and reviled by the mob He announced to his fellow exiles that in afflicting them Yahweh was preparing the Hebrews for a great service to the world They would be restored after trial and suffering and be the instrument in fulfilling a great mission in the world Jeremiah was more than prophet, he, too, was a statesman, and played a part during the second great siege scarcely inferior to Isaiah's in the first

These, then, were some of the prophets who exalted the religion of the Hebrews, raising it slowly and steadily from a low primitive thing to ever higher levels Note how Yahweh has been gradually transformed The Yahweh of many preceding centuries was a tribal god, dwelling on the mountains, a jealous god, terrible, cruel, delighting in sacrifice, a creation of the barbaric tribal mind It is otherwise now, *that* Yahweh has gone The Yahweh of these later prophets is a transformed Yahweh He is now the God of the whole earth, omnipotent, merciful, all He requires of man is "to do justly, to love mercy, and to walk humbly with God"

Hebrew Conscience Created

The prophets left their mark on all subsequent history The Hebrew conscience was created to live on after the destruction of Hebrew national life But for this racial self-consciousness the

* *The Legacy of the Ancient World* Professor De Burgh

Moses), and "moreover there is little that goes back to the time of Moses. The whole framework was constructed by a school of priestly writers in Babylonia during the exile."

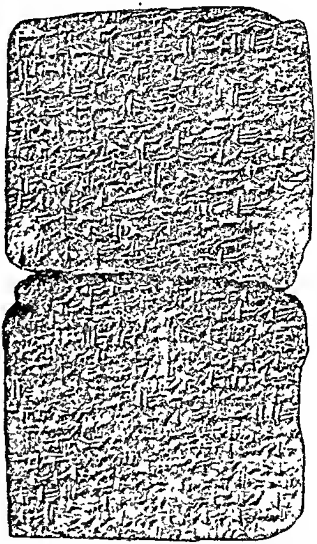
These writers devoted themselves to the study of such ancient writings of their race as survived. They engaged themselves in restoring the law, which had been lost, and in re-writing other sacred writings, the remnants of the earlier national literature, and putting into written form extant tradition. These writers were removed by centuries from the events they describe. Parts of their account are probably the imaginative interpretation of events by these pious and zealous chroniclers. The first five books of the Old Testament are a compilation, then, from previously existing material,—written documents and extant tradition. "The Pentateuch is the final literary unity known to Jewish tradition."

First Jewish Bible

What happened during the exile, or rather we should say immediately the exile ended, was nothing less than the establishment of the Law, and when Ezra and the other Jewish leaders returned to Jerusalem, the foundation of the Jewish Synagogue. The Pentateuch was the first Jewish Bible; it was followed by two additions, as we shall see

Thus the legacy of the exile and these priestly writers was the Old Testament. The original collection of Hebrew Scriptures was the Pentateuch, to that, at a later date, was added a collection of prophetic writings, and, later still, was added a miscellaneous collection of writings, which included Psalms, Proverbs, Job, Song of Songs, etc. The completed Hebrew Bible is entitled: "Law, Prophets, Writings." Professor George Gray writes: "The whole, or substantially the whole, Law was accepted by 444 B.C.; the 'Prophets' became part of Jewish Scripture not improbably soon after 250 B.C.; and the 'Writings' gradually obtained the same position within the next two or three centuries."

These three collections circulated in separate rolls (written on rolls of parchment or papyrus), but not in the form of one book. The Old Testament canon was not finally fixed until the Christian era had begun. The probable date is A.D. 100. By what stages the individual books were formed into a single collection is not clear. In the interval much had happened, and why certain writings were admitted into the canon of the Old Testament and others excluded is a subject involved in some obscurity.



[From "Ancient Times" (Breasted)

Letter of the Egyptian Governor of Jerusalem telling of the invasion of Palestine by the Hebrews (14th century, B.C.) *For interpretation of this letter see p. 120, col. 2*

ASSYRIO-BABYLONIAN EPICS AND LEGENDS

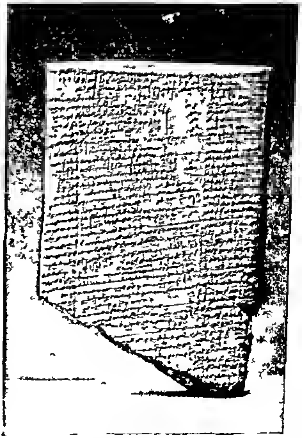
The illustration on the previous page is a letter of the Egyptian Governor of Jerusalem telling of the Invasion of Palestine by the Hebrews (fourteenth century B C) The letter is a clay tablet written in Babylonian cuneiform by the terrified Egyptian governor, who begs the Pharaoh for help, saying "The Khabiru (Hebrews) are taking the cities of the king No ruler remains to the king, my lord, all are lost" The king of Egypt to whom he wrote thus was Ikhnaton, at a time when the Egyptian Empire in Asia was falling to pieces This letter is one of a group of three hundred such cuneiform letters found in one of the rooms of Ikhnaton's palace at Tell el Amarna (or Amarna), and called the Amarna Letters, the oldest body of international correspondence in the world We find in them the earliest mention of the Hebrews.

[Mansell

THE FLOOD STORY

Most of the writings and the languages of ancient peoples can now be deciphered and understood The knowledge of Babylonian writing and speech and of those of other nations was lost for many centuries There was an extensive Babylonian literature as early as 4 000 B C It was to Babylonian and Assyrian writings that Old Testament writers long centuries afterwards were indebted for example there are the Babylonian poems of Creation and the Old Babylonian Story of the Flood, recovered from Assurbanapal's library of clay tablets

A portion of the clay tablet containing the Story of the Flood is in the British Museum It deals with the Legend of the Deluge, and is one of a series of twelve tablets found during excavations at Nineveh This legend is practically the same as that which found its way into the Book of Genesis The tablets are known as the Gilgamish Series, and bear a description of the life and exploits of Gilgamish The account of the Deluge as set down on the Gilgamish Series is that given to Gilgamish by his ancestor Uta Napishtim It contains descriptions of the building and loading of the ship, the cyclone and its effects, the abating of the storm, and the settlement of the ship on the Mountain of Nizir.



[British Museum

PORTION OF THE FIRST "CREATION TABLET" *See page 124*

§ 6

ORIGINS OF SOME *GENESIS* STORIES

BEFORE we pass to remarkable developments that took place during the four centuries preceding the advent of Christianity—they used to be called "the years of silence"—let us say a word about some Old Testament problems One of the problems is that of *ultimate* origins

It is easier to explain the formation of the Hebrew Bible as a whole than to get at ultimate origins in time, places, and persons Under the symbols of "J" and "E" and "P" scholars refer to original writers who gave the earliest literary form to the events and stories told in the Pentateuch * "J" probably wrote about the year 900 B C, and "E" about 750 B C This was *after* King Solomon's time, when the united Hebrew kingdom had split into two "J" belonged to the southern kingdom and 'E" to the northern kingdom "P" belongs to the exile period of priestly writers, about which we have just been speaking The writings of "J" and "E" were largely combined by these priestly redactors, and hence repetitions, additions, alterations, and inconsistencies in the books as we have them

The *Genesis* Story

The story of the Creation and of Eden and the Fall was originally written as in *Genesis* by the two writers whom scholars call J" and 'E" Stories like that of the Creation and the Deluge go back to myths and legends of a far older time than that of Hebrew history The creation story reflects the influence of Babylonian speculation, and other stories, the Flood for example, are adapted from old world Babylonian stories and legends "All primitive peoples begin their history with an account of the foundation of the world and the origins of man The Hebrews developed several theories and blended them in the Biblical narrative In the beginning there was a divinely created pair, Adam and Eve, and they were the original ancestors of everybody

[Courtesy of the Illustrated London News

One of the finest known representations of Baal The beautiful Stela (about 4½ ft high) showing the god hurling a spear pointed thunder bolt and a small figure (right) probably a King of Ras Shamra seeking his protection The early Israelites were prone to be drawn to the worship of Baal instead of their own God, Yahweh

There was a simple stock to begin from, a single language, a definite home But as men multiplied life became debased and cruel, and the pleasant simplicity of Eden went for ever *

'Then came the raging flood, as a punishment

* 'J and E and 'P need not each be one man, but many

* Like the Greeks and the Romans the early Hebrews placed the golden age at the beginning of their history

[Courtesy of the Illustrated London News

A DEAD KING'S HOUSEHOLD SACRIFICED AS HIS RETINUE IN THE BEYOND: A RECONSTRUCTION DRAWING BASED ON DISCOVERIES AT UR

A startling discovery at Ur—fifty-nine skeletons in a royal tomb—proved that in the fourth millennium B.C., when a Sumerian king was buried, all the members of his household, *men and women*, were killed and buried with him to minister to his needs in the next world. The victims were stretched out where their mouldering skeletons were found more than 5,000 years later.

National Gallery, London] [*Mansell*

THE ANGEL RAPHAEL AND TOBIAS
(By Verrocchio)
Illustrating the well-known story from the Apocrypha (*see page* 128)

They were swifter than eagles
They were stronger than lions

Ye daughters of Israel, weep over Saul
Who clothed you in scarlet, with other delights
Who put on ornaments of gold upon your apparel

How are the mighty fallen in the midst of the battle!
O Jonathan thou wast slain in thine high places
I am distressed for thee, my brother Jonathan
Very pleasant hast thou been unto me
Thy love to me was wonderful
Passing the love of women
How are the mighty fallen,
And the weapons of war perished!

[From the original in the British Museum

Reduced facsimile of a page of the Pentateuch in Hebrew ninth century

This non-religious poem does not stand alone For instance, there is *The Song of Solomon*, a collection of voluptuous love songs which was classed as Scripture only after much hesitation The Song was included in the canon probably because it was ancient and a supposed work of Solomon's, "or because the men of the Great Synagogue *explained* it as an allegory portraying the bond of love between Jehovah and Israel" Thus the wise men of the synagogue were fearful of omitting it from the sacred writings Hastings' *Dictionary of the Bible* admits that its plain language cannot be soberly interpreted as allegory and that it is not a work of high religious value, or a sacred poem It was doubtless, in its present form, written centuries after Solomon's time "It is in no sense a religious work Some believe it to be a disordered dramatic idyll, but more probably it is a collection of unconnected love lyrics such as were sung at Jewish wedding feasts Their beauty, their sensuous passion is undeniable We do not wonder that Goethe praised them highly They are voluptuous without being coarse There is in them, moreover, a sensitive delight in nature which is rare in Hebrew literature" (Dr Barnes)

[Copyright. By permission of Landeker & Brown Ltd., London, E.C.4

'By the rivers of Babylon there we sat down, yea, we wept when we remembered Zion'

From the painting by Herbert Schmalz illustrating Hebrew literature during the period of Exile (see page 125)

Literary Genius

We mention all this simply to illustrate that the great literary genius of the Hebrews was not confined solely to the 'magnificent imagery and flashing eloquence' of the prophets, to the sublime psalms, and the 'wisdom literature' of books like *Job*, *Proverbs* and *Ecclesiastes*. The Old Testament contains literature of unsurpassed merit but it is not the whole of Hebrew literature. For example *Ecclesiasticus* is not in the canon but in the Apocrypha; it ranks as one of the finest examples of the wisdom literature of the Hebrews. One of its best known passages will bear repeating, one of the noblest eulogies ever penned:

> Let us now praise famous men
> And our Fathers that begat us
> The Lord hath wrought great glory by them
> Through his great power from the beginning
> Such as did bear rule in their kingdoms
> Men renowned for their power
> Giving counsel by their understanding
> And declaring prophecies
> Such as found out musical tunes
> And recited verses in writing
> Rich men furnished with ability
> Living peaceably in their habitations
> All these were honoured in their generations
> And were the glory of their times
>
> Their seed shall remain for ever
> And their glory shall not be blotted out
> Their bodies are buried in peace
> But their name liveth for evermore

The Apocrypha contains literature of surpassing beauty. It was for some other reason than that it is a horrible tale that *Judith* was not included in the canon. The grim drama of *Judith and Holofernes* is a finely told story of militant nationalism exemplified in the person of a patriotic, treacherous, beautiful woman. The literature of the Hebrews must have been far more extensive than we know; how much of it was lost during the disasters that befell the nation there is no means of knowing.

But let us return to complete our historical summary and see what the effects of the Exile were.

(Continued on page 177)

SIR JAMES JEANS

His work as astronomer, physicist and mathematician, and his books *The Mysterious Universe* and *The Universe Around Us* have earned him world fame. He was born in London and is now fifty-seven years of age. He was elected President of the British Association for 1934. His attempts to construct a philosophy out of modern science have, like those of Sir Arthur Eddington, attracted much attention, and he believes that the change of outlook will be away from the materialism and strict determinism of last century towards something which will accord better with our everyday experience.

SCIENCE AND MODERN THOUGHT

CHAPTER III (*continued*)

CREATIVE EVOLUTION AND EMERGENT EVOLUTION

WE have said (page 84) that it is not yet scientifically proven that natural selection *alone* is the one thing that explains the method of evolution We referred to Henri Bergson's book, *Creative Evolution*, so much discussed at one time Bergson holds, as we have said, that there is some original "vital impulse" (*élan vital*) behind the evolutionary process

[Photo Henri Manuel

HENRI BERGSON

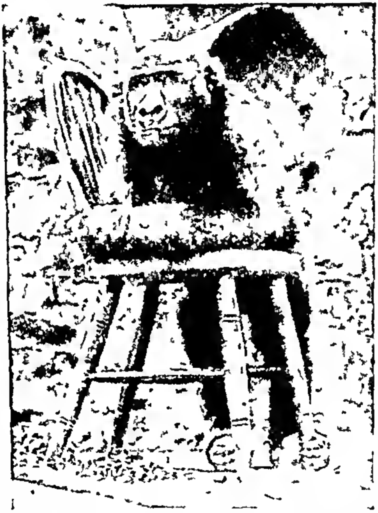
The eminent philosopher and author of *Creative Evolution*, a book which has exercised enormous influence

This doctrine maintains that the vital urge is seeking in different ways to realise itself, it belongs to the creative activity of the universe as a whole, and is not confined to mere animal life The evolutionary process, it is said, is along definite lines, and Bergson denies that it has anything to do with natural selection or any purely determinist process, he ascribes it to his *élan vital*, a vital need and urge within the organism "The essence of reality is *becoming*, that is, it is a continual and active process, a creative evolution" This is more a philosophical conception than one with a sound scientific basis

There is also the hypothesis of Emergent Evolution, which its leading exponent, Professor Lloyd Morgan, claims is a strictly scientific conception The theory assumes that real novelty emerges from time to time in the course of cosmic advance The theory supposes an independent spiritual principle which enters into association with matter and is a directing agency in the evolutionary process Professor Lloyd Morgan uses the term "emergence" to describe the appearance *at particular levels or stages of evolution* of the *new*—new properties and qualities and faculties in living organisms These qualities are not present in the germ, or embryonic state, or any stage of development prior to that in which they appear, but "emerge" in the course of evolution Life and mind, for example,

matter from his knowledge of non living matter, but he might say that his inability was due merely to his ignorance. It would be impossible to prove that he never can make the deduction. If, on the other hand, the mechanist did succeed in deducing the behaviour of living matter from dead matter he would have disproved Emergent Evolution. Hence Emergent Evolution is a theory that cannot be proved, but which may be disproved. The arguments in its favour are that it is inherently reasonable, it is consonant with the present state of our scientific knowledge, and it sounds less improbable than the theory of pure mechanism.

Sir Frederick Hopkins, one of the most distinguished investigators of the chemistry of living things, devoted his presidential address to the members of the British Association (1933) to that branch of science which is concerned with living organisms. He described how the methods of chemistry had succeeded in explaining a very large number of happenings in the life of an organism which hitherto had been assigned not to any physico chemical mechanism but to mysterious and unexplainable "vital" action. While he explained that known physico chemical processes went a long way in giving an adequate description of life and that one day such description would go a long way further in explaining the nature of life, he concluded with the cautious words "There yet may be higher levels calling for discussion in quite different terms." In other words to explain the products of living activity is not the same as explaining life itself. Life cannot be described in physico-chemical terms alone.



(Photo: F. W. Bond)

GORILLA

How did Man become Man? What process of Nature transformed ape into man? The biologist cannot give a definite answer. The theory of emergent evolution is explained in this chapter: it is not perhaps widely held.

Life is fundamental, and it is not in the analysis of this or that aspect of it but rather in the study of living organisms as a "whole" that a solution of the problem is to be looked for. Dr Bavink asks "What is the total impression which the world makes upon us after what we have heard about its material and its living side? I think we may surely say this, that it may also be regarded as a whole, as a 'psycho physical' system which both from the physical and from the psychical point of view, shows a structure in stages which lead from lower to higher units. In this sense it is a cosmos and not a chaos. From the atom to the world of fixed stars, from amœba to humanity, there is an almost uninterrupted series of steps in the formation of ever higher and more comprehensive wholes."

No Solution

Biology has many perplexities on the waiting list to be solved

It is plain that in all these theories there is no finality, no approach even to agreement Our belief or disbelief in the theory of emergence must rest, at present, on theoretical grounds Whether we accept or do not accept, the originative and creative principle of emergence is no more a solution of the mystery than the theory of the origin of mutations or the theory of natural selection is a complete explanation of the process of evolution For example, to the question, What makes emergents emerge? there is no answer, we can only assume an activity which is given various names such as the directive activity of an Unknown Power or a Divine Being giving expression to a divine purpose

These questions of ultimate origin and ultimate universal purpose belong to the province of philosophy Science is only descriptive, descriptive of the *processes* of evolution so far as they can be ascertained and so far as they can be described A good deal more remains to be said of discovered facts and various theories of interpretation but we shall reserve them until we have gone a little further in our study, when we shall return to the subject in a final summing up Obviously all the questions we have touched on are closely related to the larger ones of the origin and nature of life, to the relation of mind and body, and to the deeper secrets of the universe and the life of man

Such questions will be best treated together under the heading of Philosophical Implications

(*Continued on page 135*)

LITTLE BIOGRAPHIES

IV

CHARLES DARWIN

(1809 1882)

[Rischgitz

CHARLES DARWIN

THE publication of Charles Darwin s *The Origin of Species* marked a turning point in the history of European thought He was born at Shrewsbury son of Dr Robert Darwin and grandson of Erasmus Darwin By the age of eight his taste for natural history was already developed and the orthodox curriculum of an English public school left him uninterested He was sent to Edinburgh to study medicine but that project was abandoned after two years Afterwards he was sent to Cambridge with a view to taking a degree as a preliminary to the ministry as a future profession At Cambridge he made the acquaintance of Henslow the professor of botany the young student was known as the man who walks with Henslow At a later date it was Henslow who was the means of Darwin s joining the staff of the *Beagle* about to set sail on its memorable expedition to extend the survey of South America Darwin acted as naturalist without any salary sharing the captain s cabin This voyage lasted five years and as Darwin himself said was by far the most important event in his life and determined his whole career Yet it depended on so small a circumstance as my uncle offering to drive me thirty miles to Shrewsbury which few uncles would have done and on such a trifle as the shape of my nose

Thirty Years Work

He was the keenest observer and his study of the character of South American fossils and living species on Galapagos Archipelago was the origin of his views on the transmutation of species He thought he saw convincing evidence of this In 1837 the year after his return he says I opened my first notebook of facts in relation to origin of species about which I had long reflected and never ceased working for the next thirty years

In his young days he was overflowing with genial spirits and energy which spent themselves in a crowd of varied interests He became a

victim of dyspepsia however and one of his biographers writes It is no exaggeration to say that for nearly forty years he did not know one day of the health of ordinary men and that his life was one long struggle against the weariness and strain of sickness And this is the man whose amazing industry during a long life was simply colossal!

Darwin tried to sum up the qualities that led to his success as follows My success as a man of science whatever this may have amounted to has been determined as far as I can judge by complex and diversified mental qualities and conditions Of these the most important have been the love of science unbounded patience in long reflecting over any subject industry in observing and collecting facts and in a fair share of invention as well as of common sense He had the gift of preserving a perfectly unbiassed mind which above everything else was intent on getting at the truth of things He was always ready to abandon or modify any opinion he might have formed if fuller knowledge rendered that necessary

The Origin of Species was published in 1859 on correcting the final proof sheet he wrote Oh good heavens! the relief to my head and body to banish the whole subject from my mind The book was received with a storm of criticism except by such men as Charles Lyell T H Huxley Sir John Lubbock etc the theologians launched every kind of abuse against its author He remained quite unperturbed

The storm of controversy reached its climax at the British Association meeting at Oxford in 1860 the occasion of the famous verbal chastisement of Bishop Wilberforce at the hands of T H Huxley

Since Darwinism is the subject of a chapter in the present work it is not necessary to go into it here Darwinism in its broad sense as meaning the doctrine of Evolution is now practically universally accepted The full title of Darwin s book is *The Origin of Species by Means of Natural Selection* He advanced the theory of natural selection as an explanation of the *method* of evolution Most of what he wrote about this still remains valid But not all there has been marked progress in biological science since his day and in particular that branch of it which deals with heredity On that subject there is still a difference of opinion among specialists But no competent naturalists have any doubt as to the validity of the facts of evolution as a *modal* theory of the way in which living creatures have come to be as they are Where there is difference of opinion it is in regard to the *factors* which account for the fact Biologists still remain very much in the dark about the causes of variations Darwin himself never claimed to explain the factors operative in evolution all he did was to make broad general sations based on the observable processes of variation heredity natural selection sexual selection and the like Of ultimate causes he did not presume to speak

[R hgitz

CHARLES DARWIN S HOUSE AT DOWNE KENT

(Garden view) Here he resided from 1842 until his death in April 1882 His study is the building on the left

His *Descent of Man* was published in 1871 it was the natural sequel to the *Origin of Species* With all his greatness man is a scion of a stock common to him and to the Anthropoid Apes Darwin mercilessly proved man s affiliation to a vaguely known primitive stock He effected a complete revolution in biological science It was not merely his marshalling of the evidences of evolution that won the conviction of most intellectual combatants it was *his detailed* explanation of the possible *how* of the sublime process

He lived a noble life and few great lives have been so thoroughly free from littleness He died in 1882 and was buried in Westminster Abbey

Patiently laboriously humbly he worked towards the truth—the truth that has done so much to make us *free*

V

THOMAS HENRY HUXLEY

(1825–1895)

[Russell

T H HUXLEY

T. H HUXLEY was a notable figure of the Victorian era not only as a man of science but as a writer gifted with a fine clarity of style His was a great influence in moulding public opinion when the new doctrine of evolution was profoundly exercising men s minds

He was an authority on comparative anatomy and made some big original contributions to science in the domain of Zoology, but he shone most as a brilliant advocate of Evolution and in helping Darwin to win his evolutionist battles His famous controversy in the pages of *The Nineteenth Century* with W E Gladstone about the Gadarene swine and inspired scripture in general is still a vivid remembrance of the older generation of to day So too his withering encounter with Bishop Wilberforce at a British Association meeting at Oxford in 1860

Two of Huxley s characteristics were his clear thinking and his intellectual honesty Most of his clashes with Theology had to do with subjects in regard to which the transcendental interpreter took up the *rôle* of scientific describer *e g* as to the precise way in which Animate Nature arose or the manner of Man s emergence Huxley was himself incredulous of man s philosophical and theological interpretations but his fierce opposition was not if we understand him aright to theological interpretation as such he was against theological trespass into the field of scientific description and against the attempt to fence off any scientifically discussible problem as a preserve from which science was excluded As he humorously remarked he could not endure the numerous warning sign boards with the notice "No Thoroughfare—By Order—Moses If we understand him aright he did not think that the difficulty of believing in God was affected by the modern advance of science He wrote The philosophical difficulties of Theism now are neither greater nor less than they have been since Theism was invented " *

In the midst of all his activities Huxley would always find time for lecturing to the working classes In a letter he said I want the working classes to understand that science and her ways are great facts for them—that physical virtue is the base of all other and that they are to be clean and temperate and all the rest—not because fellows in black and white ties tell them so but because these are plain and patent laws of nature which they must obey under penalties '

As his grandson (Julian S Huxley) tells us, Huxley had a great capacity for reverence although represented during his lifetime as a prince of infidels and arch-enemy of religion Thomas Huxley was in reality a man deeply and essentially religious by nature He was a puritan and iconoclastic spirit but one with profoundest capacity for reverence That capacity he expended chiefly in reverence for truth and for moral virtue and it upheld him in a life s work almost superhuman in its arduousness It was Huxley who coined the word agnosticism a word that has been often misrepresented and misunderstood In Huxley s case it meant an attitude of mind where certain problems were incapable of verification

We have dwelt on this side of Huxley s work rather than the scientific side of it because it is perhaps his most important legacy to us One of his biographers writes Those who care even more for freedom of thought than for mere advancement of knowledge may well consider the effect produced by his lectures and essays upon the minds of English speaking peoples to be the most important result of Huxley s work between 1860 and 1870 But they represent only a small part of the work he actually did during this period The record of it is remarkable not only his purely scientific work but the administrative work he did in connection with various learned societies and the ceaseless energy he devoted to his essays his lectures, and every form of intellectual culture

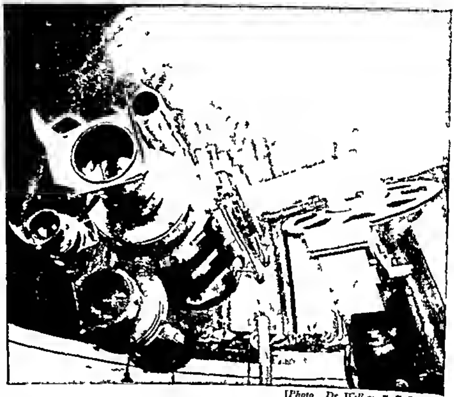
He was born at Ealing in 1825 the son of a master in a school there In his early days like Darwin he got his impetus to study biological science on a marine survey expedition as an assistant surgeon he went out on H M S *Rattlesnake* commissioned to survey the eastern shores of Australia This scientific work brought him some fame and he was elected a Fellow of the Royal Society For thirty years he was an intimate friend of Charles Darwin He died at Eastbourne on June 29 1895

* Sir Arthur Thomson s *What We Owe to Huxley*

CHAPTER IV

THE NEW EPOCH

What is Happening to Science



[Photo Dr William J S Lockyer

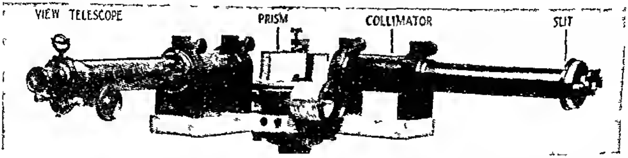
A FOUR FOLD STELLAR CAMERA

Wonderful photographs of the passage of meteors are obtained by means of this instrument which was presented by Dr Robert L Mond to the Observatory at Sidmouth The four cameras shown are mounted so as to point towards the North Pole and remain rigid Prolonged exposure of the plates as the earth revolves produces remarkable images of stellar phenomena such as are shown on page 139 The cameras can also be adjusted to follow the courses of the stars and photograph them as small discs

BEFORE we go on to summarise the results of some other branches of Science, in addition to those we have already referred to, it will be helpful to readers not familiar with these things if we explain how it is that science is becoming more inter related and more unified, that is to say, how different branches of modern science dovetail, as it were, one into another, nowadays the individual sciences can no longer be treated as distinct and separate As we said on a previous page, astronomy, physics, chemistry, and biology at points merge into each other, every science is in some way complementary to some other Perhaps this statement requires a little further elucidation

The boundaries between the great divisions of science grow less definite as knowledge continues to advance Not so long ago the four main sciences, astronomy, physics, chemistry, biology, were regarded as quite distinct Now they overlap, and they overlap to such an extent that new " borderland " sciences have come into existence linking one on to another Thus connecting physics and astronomy we have the science of astro physics, connecting physics and chemistry we have physical chemistry, connecting chemistry and biology we have bio chemistry, and so on

For example The old text books divided the science of physics into the four departments of Light, Heat, Magnetism, and Electricity The province of Astronomy was the study of the heavenly bodies But recent scientific knowledge has revealed that a clue to the nature of light and electricity and other " forces " is to be found in



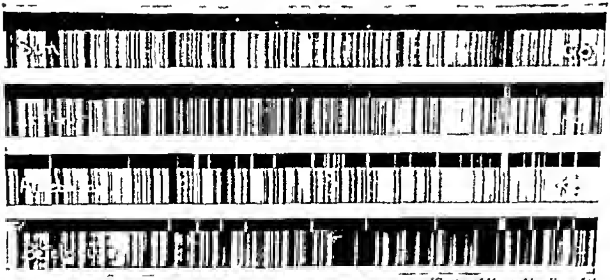
[*Courtesy of Messrs Adam Hilger Ltd.*

The spectroscope is an important instrument in the study of the stars; the technique of stellar photography is too complicated to explain in a few words. Scientific photographs of the heavenly bodies supply such information as enable astronomers to get the spectra and magnitude of stars, and their distances, temperature, mass, motion, ages, and internal conditions.

the atoms of the stars, for we now know that the atoms of the stars are of the same kind as terrestial atoms and that a study of the nature of stellar atoms and radiation is an invaluable aid to the physicist studying light and electricity in his laboratory. A knowledge of the constitution of the stars is as vital to the physicist as to the astronomer—hence the science of Astrophysics, which is concerned both with the constitution of the heavenly bodies and the phenomena that go on inside the stars.

Again, the chemist studied the chemical elements, but now that *all* the chemical elements are found to be nothing more than combinations and permutations of particles of electricity (electrons and protons) the chemist links hands with the physicist, and we have physico-chemical science.

Once more, the biologist deals with the phenomena manifested by living organisms, but as living organisms also are now more intimately understood in the light of the modern electronic theory of matter, we have the new science of bio chemistry. Bio chemistry asks: Can we be



[*Courtesy of Messrs Adam Hilger Ltd*

A MESSAGE FROM THE STARS

The illustration shows the spectra (see previous page) of four stars. All light is a blend of lights of different colours, and whether the light comes from a star or from any other source, it can be analysed into its constituent colours. The different colours of light result from waves of different length. Sunlight is a blend of all the colours of the rainbow. The analysed light spreads out into a strip or pattern of lines and bands of continuously graduated colour which is described as a "spectrum"; the order is from violet through green and orange to red which has the longest wave length; violet is the shortest. The spectrum of a star tells a great deal about its constitution and its life story.

certain that there is a natural boundary between the living and the not living?

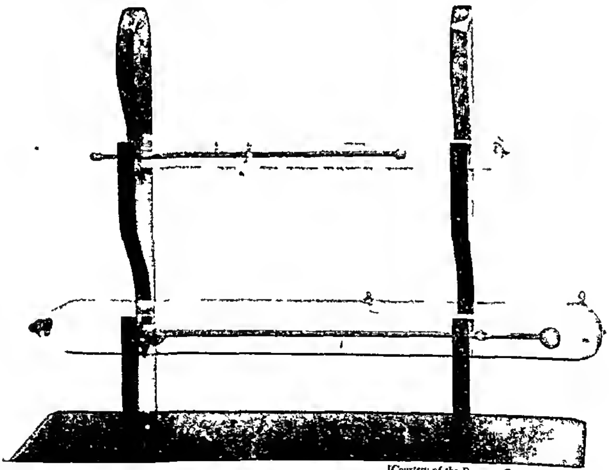
As a matter of fact, every biologist now recognises that there is a legitimate chemistry and physics of the living body, and desires their further advance; but the point is that many biologists are convinced that there are distinctively vital phenomena which remain *irreducible*, such as irritability, growth, development, heredity, and variation. But there is not in these phenomena anything that contraverts the laws of chemistry and physics.

§ 1

SCIENCE, then, as a whole is becoming more unified, although scientific men themselves are becoming more specialised. Each department of science now so abounds in details that it takes a lifetime to master it, and yet at the same time the threads that connect all these departments together are steadily becoming more apparent.

We can see how the process of unification comes about if we consider the changes that have come over the science of physics during the last fifty years. As we have said, the old text books divided the science of physics into the four departments of Heat, Light, Magnetism and Electricity. This clear cut division no longer exists. A great unification was effected when James Clerk Maxwell showed that light is

(*Continued on page* 140)



[*Courtesy of the Director S ence Museum London*

CROOKES TUBES

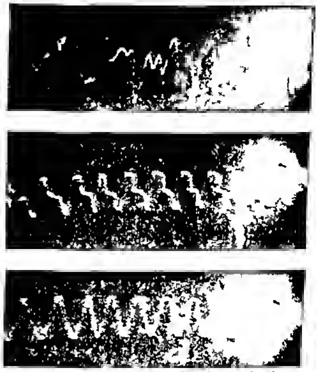
They are vacuum tubes from which nearly all the air has been pumped. How Sir William Crookes in a beautiful experiment by producing an electric discharge in the vacuum tube discovered certain rays which he thought to be a new or fourth state of matter will be explained in another chapter. What he had really discovered (although he did not know it) was the existence of electrons which compose all matter. That knowledge was to come later with the discovery of radium.

MARVELS OF PHOTOGRAPHY

[Photo F. Davidson & Co

HOW FAR THE CAMERA SEES

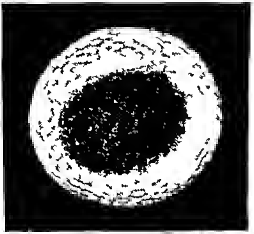
By means of infra red rays the range of photography has been vastly extended. While the shrubs at the lower right corner in the photograph were 20 yards from the camera the mountain peaks (Himalayas) were 64 miles away



[By Courtesy of Nature

PHOTOGRAPHING VIBRATIONS

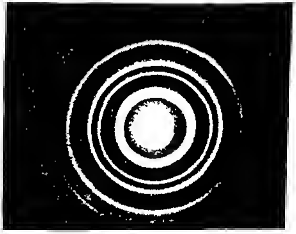
This photograph shows different types of vibration waves in metal rods (in this case duralumin). The experiment consists in tapping a rod at one end with a small hammer and then making visible by electrical means the train of waves which occur as a result of the impact



[Photo National Physical Laboratory

DETECTING THE FLAW

This X Ray photograph of a golf ball clearly reveals an imperfection in its composition



[Photo G. P. Thompson

INVISIBLE TO HUMAN EYE

An amazing photograph showing electrons appearing as waves in passing through a thin metal film

WONDERFUL STELLAR PHOTOGRAPHS

A stellar photograph taken with a fixed camera causing each star to leave a curved trail on the photographic plate, due to the earth's rotation. The straight line is a large meteor which chanced to dash through the earth's atmosphere while the plate was being exposed. (See illustration page 135.)

[Photo Dr William J S Lockyer

A Nebula and a Fireball (meteor) the latter crossing the plate in $\frac{1}{2}$ second the former hardly moving in a million years

[Photo National Observatory Prague

an electro magnetic phenomenon He showed that electric and magnetic forces are propagated through space in the form of waves Now it had been known for a long time that light also streams through space in the form of waves, and the speed at which it does so was well known Maxwell showed that the electric and magnetic forces travel at the same speed as light It was shown, by experiment that these waves can be reflected and refracted just like ordinary light waves There could be no doubt that light waves are a form of electro magnetic waves an important discovery The waves of wireless telephony and telegraphy are essentially similar to light waves The only difference is that they are very much longer than the waves of visible light Radiant heat and X rays are also included in this scheme X rays are only very short electro magnetic waves The novice or beginner, may not understand these points at this stage but they will become quite clear in his mind later on We are merely indicating here the point that a great unification has been effected When we study electro magnetic waves we are not only studying the nature of electricity but of light and radiant energy as well

[Rischgitz

JAMES CLERK MAXWELL

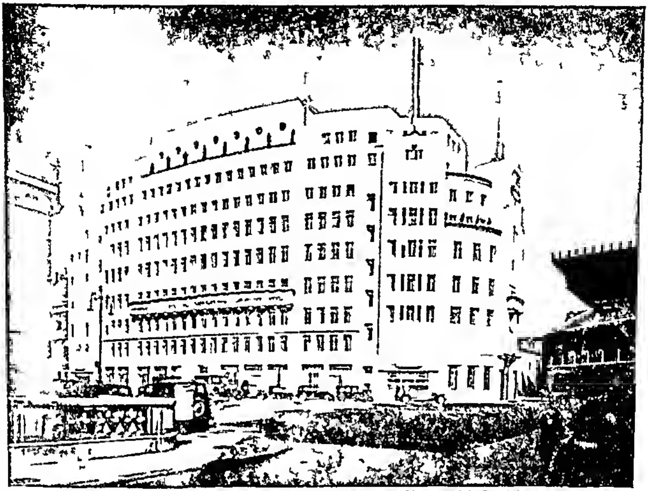
(1831 1871)

One of the greatest scientists of the age It became his life work to show that light is a form of electro magnetic waves He worked out the properties of the electrical waves which were afterwards verified by Hertz and thus he was the theoretic founder of all wireless systems

This is a specimen of the sort of unification that takes place in science *A number of apparently diverse phenomena are all seen to be exemplifications of one general phenomenon*

The analysis of the light received from the stars, which is made possible by the instrument called the spectroscope, has called the great science of astrophysics into existence The spectroscope is no new optical apparatus but the results of spectrum analysis in comparatively recent years have been far reaching The light that comes to us from the stars has by means of spectroscopy, given us an ever increasing mass of information which has been interpreted by the astronomers The philosopher Comte declared that man could never know anything as to the chemical composition of the heavenly bodies But that is just what the spectroscope *has* revealed The spectroscope is an instrument by which light is analysed, when the light proceeding from the stars is analysed we can learn what elements compose the interior of the stars Stellar atoms are mostly the same as terrestrial atoms The stars have become as it were gigantic laboratories in which the physicist can study conditions that he could never reproduce on earth How does matter behave at super earthly temperatures and at super-earthly pressures? The stars tell us Thus observation of the stars has extended our knowledge of physics while our knowledge of physics has greatly increased our knowledge of the stars

Can this process of unifying the sciences be continued indefinitely? Are all the sciences destined to merge into one great comprehensive science? At the present time there are



[Courtesy of the British Broadcasting Corporation

BROADCASTING HOUSE LONDON

Opened in 1932 The Headquarters of the British Broadcasting Corporation The discoveries of Clerk Maxwell laid the foundation of all wireless systems (See page 140)

obviously two great groups of sciences those that deal with non living matter and those that deal with living matter Is this a fundamental division—fundamental that is to say in the very nature of things ? We have already referred to the science of bio chemistry which treats of the chemistry of living things There is also a bio physics Will these sciences ever account for all the phenomena of living things ?

At the present time there is a great divergence of opinion on this point There are some authorities who believe that nothing goes on in a living organism that will not one day be explained by the laws of physics and chemistry There are others who believe that living organisms will never be accounted for by these laws alone They assert that entirely new energies and forces unknown to physics and chemistry are involved in the phenomenon of life Biology they say will never be swallowed up by physics Suppose that they are right Does it follow that there will always be this great division in science ? Not necessarily For it may be that the science of life when it is perfected will have something of importance to give to the science of matter In fact the unification of science may be effected the other way round not by explaining a living organism in terms of dead matter but by explaining dead matter in terms of living organism But all this at present is a matter of speculation We can assert definitely from the way the sciences have developed that there is a pervasive unity running through the diverse phenomena of nature but precisely how far this unity extends we are not yet in a position to say

[Courtesy of Scientific Ideas of To-day

DETECTING A SMALL QUANTITY OF MATTER

In the left hand photograph the two pieces of paper exactly balance The balance used is very sensitive and when the single word atoms has been written with a lead pencil upon one of the papers the additional weight is sufficient to depress one of the pans as shown in the second photograph The spectroscope will detect less *than one-millionth of the matter contained in the word pencilled above*

of little bits of "matter" pushed and pulled about by forces ' The universe consisted of lumps of matter material substances wandering about in space and time in accordance with certain laws

We do not say that every man of science believed this in a literal sense, and that no one had ever thought of atoms as composite structures built up from smaller particles All that is implied is that the conception of the atom to day is a product of the present century

Now, the great change that has come over the scientific outlook is due precisely to the fact that these three things—matter, space, and time—are no longer regarded as three independent realities This change has come about as the result of two lines of investigation—the analysis of matter, and the analysis of space and time As a result of this analysis matter has been deprived of its status as a substance,' and space and time have been deprived of their indepeodent reality At the same time it has become clear that the universe is not to be described as a mechanism The old materialism is bankrupt, the materialism that was merely a materialistic conception of the universe, and of life and mind

When we have seen a little more about the beliefs of scientists as to the nature of Matter, Space, and Time, we shall see then that ' common sense tells lies about all of them,' and that not one of them is what it ' obviously ' seems to be Common sense is no guide to the actual world of reality which science discovers it to be.

The Part Mathematics Plays

The great investigator has been the mathematical physicist Can we trust the mathematician? He does not ask us to trust him blindly and everywhere When he *predicts* a thing and we later see it come to pass that gives the ordinary man some confidence For example, it was from a pure mathematical theory and

itself This reality is a matter of relations between things and not of things themselves which must remain for ever unknowable"

The method of the mathematician is measurement It can only deal with those things that can be made quantitative, that is to say, anything that can be increased, divided, or measured In any given phenomenon its measurable aspects are picked out and the relations between these aspects are given precise expression in a mathematical formula This formula enables deductions to be made For instance, if we know that a triangle has two of its angles equal, we can prove that two of its sides must be equal

Such things as beauty, intelligence, "strength of personality," and so on, are not things that mathematics can concern itself with, since such things cannot be given quantitative form

It is obvious then from the little we have said, that mathematical physical research is conducted in an ideal spirit of complete detachment it is quite impersonal, free from prepossessions of any kind, a mathematical formula can never tell you what a thing is in reality, all it does is to tell you how a thing behaves, and its relation to something else, never what the thing is

Although the mathematician's formula is a symbol it is *something real*, he understands perfectly well the meaning of his symbols, but he does not know what the thing itself is, the definite reality that the symbol stands for He can picture and describe what goes on inside an atom although no atom has ever been seen by mortal eye, not even through an ultra microscope, far less has any *electron, infinitely smaller*, been seen The existence of the invisible electron is only known when it is in interaction with something else, *then* it emits rays or flashes of light To the physicist these rays and the way they behave tell a great deal, and from such knowledge a great deal more can be deduced from the observed *facts*

§ 4

THE mathematician starts out with premises which are usually based on observed phe- ... the premises are axioms that are universally accepted We are rather anticipating what we are coming to, but we may say that if a mathematician knows that the electrons in an atom are jumping from orbit to orbit in a certain way he can deduce what kind of light that atom is sending out He puts the information he is given about the atom into a formula and then reasons about the formula Clerk Maxwell *knew that electric and magnetic forces, when* measured, were found to be related in a certain way He summed up these relations in a formula and deduced from it that electromagnetic forces were propagated with the speed of light through space in the form of waves The deduction has been proved true When Einstein was told that experiment showed that the velocity of light did not depend on the motion of the observer he was able to prove that in that case, space and time must be relative

Now the wonderful thing is that within the life-time of the present generation men pursuing the path of mathematics should have been able to transform entirely our views of the nature of the physical universe It began, of course, with certain observed phenomena, the nature of which is explained in another chapter The observed phenomena resulted in the discovery of X-rays, in the discovery of radium, and finally the discovery of the electron to be developed later into the theory of the electric constitution of matter of every kind, to be followed by the revolutionary Quantum Theory

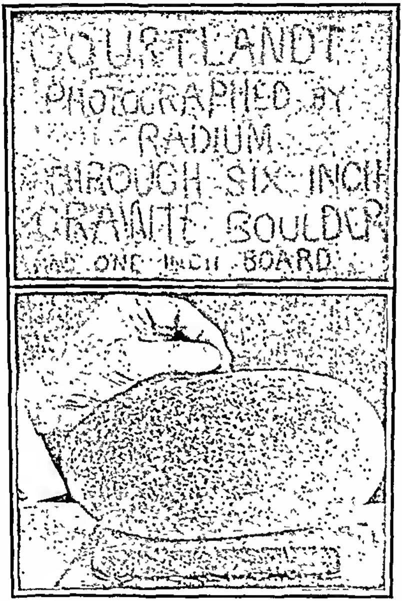
The discovery of these things then resulted in the confounding of "common sense" As with the analysis of matter, so with the analysis of space *The analysis of what the ordinary* man thinks of as "space" revealed that there is no such thing as "empty" space that space is as different from what it had been imagined as matter had turned out to be, time is mathematically analysed, with a like result, and by and by Einstein envisages a new world of four dimensions *Not one of these revolutionary* concepts now rests on mathematical theory alone, they are experimentally proven The first great shock for the believers in the independent reality of space, time and matter was caused by Einstein's theory of relativity In

this theory space and time are deprived of their status as independent objective realities. It would take up too much space and this is not the proper place to launch into the subject of the four-dimensional continuum. Sufficient to say that the four-dimensional world is conceived as a sort of blend of space and time, and that "matter" is not an independent enduring substance inhabiting space and time, but is intimately connected with the four-dimensional continuum.

§ 5

The New Epoch

We are living in a scientific epoch which has had parallels in previous history of science, which in its advances has given man one new world after another. In the time of Copernicus, the earth, an immovable earth, was believed to be the centre of our universe, nothing more certain than that; the dignity of the earth was unchallenged, it was the ordained abode of men, and man the chief purpose of creation. Copernicus and Galileo dropped a bombshell when they said that the sun and *not* the earth was the centre of our universe, that the earth circled round the sun and *not* the sun round the earth. Galileo was condemned by the Inquisition because he said the earth moved, or rather because he was upsetting the established religious notions of the Church about God and the universe. To say the earth was not the centre of the universe was to degrade the earth and man. The establishment of the fact that the sun is the centre of the universe marked an epoch. Isaac Newton marked another when he "saw an apple fall and discovered gravitation," which meant that the earth was ruled by a force which the sun exerted on it. The same *force which* makes the apple fall keeps the earth circling about the sun



(Courtesy of "Scientific Ideas of To-day"

PHOTOGRAPHED THROUGH A GRANITE BOULDER

This experiment illustrates the wonderful penetrating power of radium rays. Pieces of lead wire were twisted into the form of the words seen in the upper illustration These letters were laid upon a thick, light-proof envelope enclosing a photographic plate. On the top of these was laid a one-inch board, and on the top of that a six-inch boulder. A small glass tube containing some radium salts was laid on the top of the boulder. The rays penetrated the boulder, the wood, and the light-proof envelope, but were entrapped by the lead wire, and produced the photograph shown in the upper illustration. (Exposure three days.)

reasoning that the late Professor J C Adams and Leverrier predicted the existence of the planet Neptune and within narrow limits of space where it would be found in the vast sky Thereupon the astronomers set to work, and how Neptune was quickly discovered by them is one of the most dramatic discoveries in the history of science That is no solitary example, such examples are manifold In other directions, we have ample proofs that mathematics is one of the finest tools of scientific investigation and discovery over and over again the mathematician's reasoning has been confirmed later by experimental proof and actual happenings

The mathematician, in one sense is a cold-blooded mortal He deals in abstractions He takes nothing for granted He will not rely on these dangerous tools, the senses, appearances for him are too deceitful He measures everything, he works by equations, at work he has no emotions — except the joy of seeing a great mathematical structure completed and verified He sees in his mathematical theory, worked out to the last logical point, an object of surpassing beauty A mathematical writer is moved to write as follows 'The processes by which the theories are obtained are often as æsthetically important as the theories themselves A subtle, elaborate and economical piece of reasoning often affords great æsthetic pleasure, none the less real because comparatively few people enjoy it The fact that the history of a big scientific investigation, such as the Electro Magnetic Theory or Einstein's Theory of Relativity, is not generally regarded as a poem is due merely to an accident of language and education" Eddington has said "I know of passages written in mathematical symbols which in their sublimity might vie with Rupert Brooke's sonnet"

[Photo Hoppé

PROFESSOR EINSTEIN

He has changed the whole picture of the Universe as it was imagined in the nineteenth century Just as the discoveries of Copernicus in the sixteenth century revolutionised current ideas about the place of man in the universe so the Relativity Theory of Einstein will ultimately bring about a complete change in our modes of thought

Mathematicians speak in a language only to be understood by a mathematician The ordinary man confronted with the mathematical equation proving a conclusion is in the quandary of a person not knowing a single letter of the Greek alphabet and who is given the *Iliad* printed in Greek to read That is the handicap of the ordinary man, but the mathematician himself has, sometimes, a difficulty which affects himself His ideas at times cannot be translated into any language He works with symbols, and, in the region of high mathematics he builds up in his mind a pictured image, an image that cannot be put into language He is in the position of a poet who tries to put into poetry what cannot be expressed in matter-of fact prose He is not dealing with concrete things but with ideas We are thinking now of the high regions in which the mathematician works when he is trying to frame his notions of the nature of the cosmos The vision is too rare subtle too elusive to be put into prosaic every day language It cannot be given definition or described in words by the poet or mathematician to himself,

[E N A]

WHERE EINSTEIN TESTED HIS THEORIES OF RELATIVITY
THE ASTROPHYSICAL OBSERVATORY ON THE TELEGRAPHENBERG POTSDAM

This unusual structure was designed and erected in honour of Einstein the greatest modern scientist The tower rises like a mighty dreadnought a massive and impressive monument to the purpose it serves

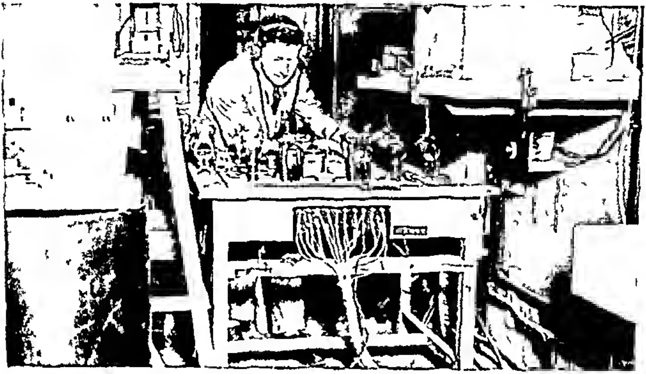
far less can it be communicated except vaguely in non mathematical language It is 'something' that eludes all that In the mathematician's mind the 'something' is the totality of the mathematical relations of one thing to another and to the whole He can only frame that knowledge that mathematical knowledge in mathematical symbols

He deals with abstract ideas, that is to say with certain conceived qualities or attributes of an object considered apart from the rest the external appearance of a thing is no guide to its intrinsic nature

Mathematical Reality

In a word mathematical knowledge does not rely on the human senses Mr Langdon Davies sums it up clearly

Human eyes being formed to help us in the struggle for existence are not necessarily satisfactory tools for fashioning a picture of reality Exactly the same is true of language which contains many snares of tripping up right thinking There exists a kind of knowledge—mathematical logic—which does not come from the senses Out of this mathematical form of knowledge and by using mathematical language, we can construct a reality which satisfies our desire for something every one can believe This reality can never be put satisfactorily into pictures so that any description which is not mathematical—that is, any word picture—is only useful as a rough guide to reality The discovery of this reality brings with it the abandoning of a common sense view of things, but apparent contradictions in scientific descriptions amounting often to paradox are due to our taking the imperfect and partial picture for the reality



[Courtesy of "The Illustrated London News"

LISTENING TO THE "SPLIT" ATOM

All atoms are built up of electrons and protons infinitely minute particles of electricity The illustration shows a section of the apparatus with which the atom was split by Dr Cockcroft and Dr Walton working at Cambridge To split an atom is to disintegrate it by using alpha particle rays as projectiles Lord Rutherford bombarded atoms and was able to knock protons out of atoms of the lighter elements The proton is the nucleus of the atom and is the positive charge of a particle of electricity In doing so he changed the constitution of the atom The above apparatus by means of which Dr Cockcroft is listening to the sounds indicating atomic disintegration is attached *to a one million volt* vacuum discharge tube

conceptions We shall not pause to explain to the uninitiated what the old classical scheme of physics was, and what has replaced it, for the moment that does not matter We are merely saying that to *grasp new and unfamiliar conceptions is not easy* The new conceptions of present day physics and relativity are not only unfamiliar to our minds, they are astonishing notions, upsetting long established beliefs about the nature of the objective universe

To grasp new conceptions of this kind means that we have first to empty our minds of fixed, established notions It means more than that we have to acquire a new point of view, a new habit of thought, a new kind of consciousness, *the mind has to be educated, as it were, to something* radically new To become familiar with a theory means something more than reading about it in an unreflecting way As we have written *elsewhere, it means taking it into oneself* in some indefinable manner—becoming "intimate" with it Only when a theory is "realised," as we say, do we feel that we truly understand it Ideas, points of view that we were able to see only in flashes become part of our normal intellectual equipment The process may well be called a growth of consciousness There are ideas which our consciousness, when it first approaches them, is, as it were, too flabby to grasp We first *have to exercise our mental* muscles Every student of a line of thought such as mathematics, which is rather outside our normal preoccupations, becomes aware of an *actual change in his* mental powers Notions so abstract that at first they seemed almost meaningless gradually become perfectly clear and permanent additions to one's *mental resources* Students of musical composition find that their capacity for mentally hearing a number of parts rapidly increases In some cases it is *almost* as if a new faculty of the mind were born and developed

The physics of recent years has made heavy

If, still persistent, you ask the mathematician, "Do you believe in a Creator?" he, if he is a nice kind of man anxious to be helpful, will give you a reasoned answer, but it will be Greek to you He will tell you all about a four-dimensional world of point events, having certain characteristics which have the quality of creating, and of permanence, a fourth dimension non-material shadow-world where time and space are one and co-existent, time and space acting as ghostly twin brethren, together, these two are creators of "events" This is all very puzzling, and the plain man will not in the least understand what his mathematical friend is talking about, although he is doing his best to tell him about the new conceptions of Relativity theory and the four dimensional continuum If he is a very frank kind of mathematician he will tell you that he knows nothing of the nature of the things whereof he speaks, all that he is talking about is the *structure* of the reality of the physical universe, of the reality underlying that he can tell you nothing

Without his mathematical accomplishments you will not understand But your common sense is enough to follow him when he explains to you that the province of physics is limited to the *structure* of reality, including other universes than ours, and all that depends upon the *substance* of reality for ever lying outside physics

Science has no loud dogmas to proclaim about "reality" The philosophy that regards man as a meaningless accident in an alien universe receives no support from modern physics As Professor Millikan says, we cannot allege against modern physics the sin of exalting the material at the expense of the spiritual With astonishing rapidity within the past twenty years man has extended his vision

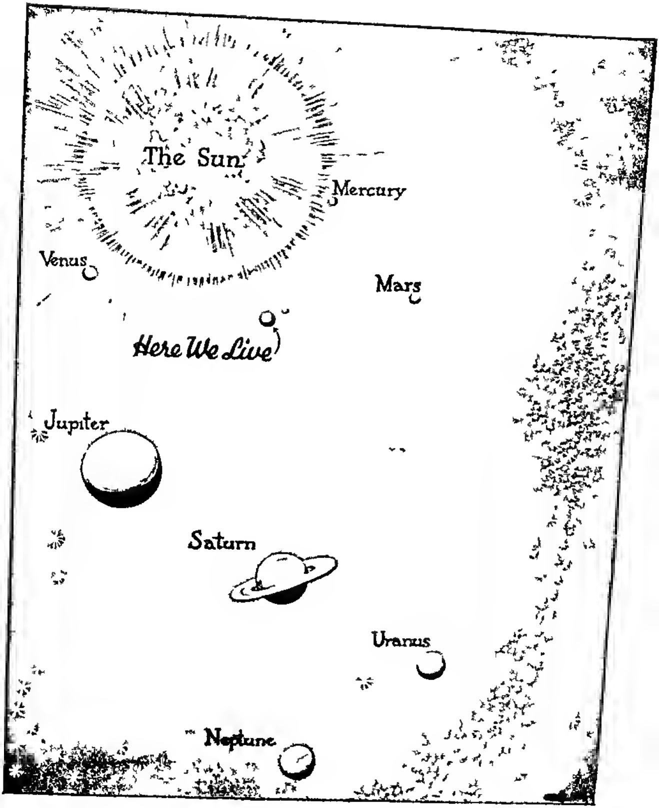
"He has looked inside the atom, a body one millionth the diameter of a pin-head and found an infinitely small nucleus one ten thousandth the diameter of the atom and arranged about it as many as ninety two electrons (in uranium) each playing its appropriate role in a symmetrical, co-ordinated atomic system He has then looked inside that nucleus and counted in uranium exactly 238 positives and 146 negatives, and he has found that *the atom changes to something else if any one of these positives or negatives drops out* He has watched the interplay of radiation upon these electrons, both within the nucleus, and out of it, and found everywhere amazing orderliness and system He has learned the rules of nature's game in producing the extraordinarily complicated spectrum of a substance like iron, for example, and it is in Sommersfield's phrase, unbelievable magic that these complicated rules never fail to predict exactly the observed results

"Again, man has turned his microscope upon the living cell and found it even more complex than the atom, with many parts each performing its function necessary to the life of the whole, and again he has turned his great telescopes upon the spiral nebulæ a million light years away, and there also found system and order

"After all that is there any one who still talks about the materialism of science? Rather does the scientist join with the psalmist of thousands of years ago in reverently proclaiming 'the Heavens declare the glory of God and the Firmament sheweth his handiwork' The God of Science is the spirit of rational order and of orderly development, the integrating factor in the world of atoms and of ether and of ideas and of duties and of intelligence"

Many people, including some men of science take science too seriously They think that science gives a far more comprehensive picture of reality than it really does Science does not find it necessary to talk about moral and æsthetic values, or human experience What science does not assume does not necessarily not exist It is true enough to say that nearly everything of real importance to man lies at present outside science

(To be continued on page 197)



THE EARTH AS A PLANET AMONG OTHER PLANETS

To face page 1 [illegible]

BOOK II—(*Continued from page 100*)

MODERN SCIENCE

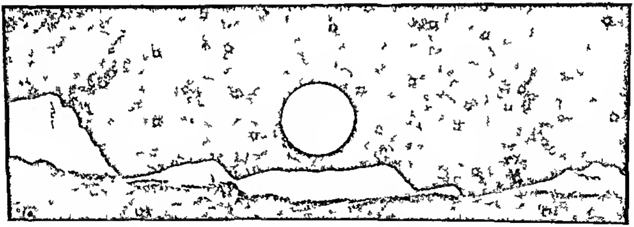
CHAPTER V

THE STORY OF OUR PLANET THE EARTH

AS inhabitants of the earth we rarely perhaps think of it as one of the planets that sprang from the sun and just as seldom may be do we think of the earth as the parent of the moon Perhaps we are less curious about the nature and constitution of the earth than we are about the far off sun and moon Familiarity here as elsewhere breeds indifference

It is known that the material of the earth is similar to that of many of the other members of the solar system the only difference is that the materials do not exist in the same proportion nor in the same form It is elementary knowledge that under suitable conditions the same type of matter can exist in three distinct forms—gas liquid and solid Hydrogen and oxygen are gases combining in proportion of two to one they become water Some of the elements in their natural condition are solid—like such metals as gold iron zinc etc

Before the present century it was believed that each element was itself and no other constant and unchanging but we know now that is not so as explained in another chapter in this work the element uranium may in fact *spontaneously* change into radium and radium *spontaneously* go through certain changes and end up as lead Such elements are termed radio active that is to say they emit rays which change their constitution they disintegrate and no physical agency known in the whole universe can either inhibit or expedite it in the tiniest degree

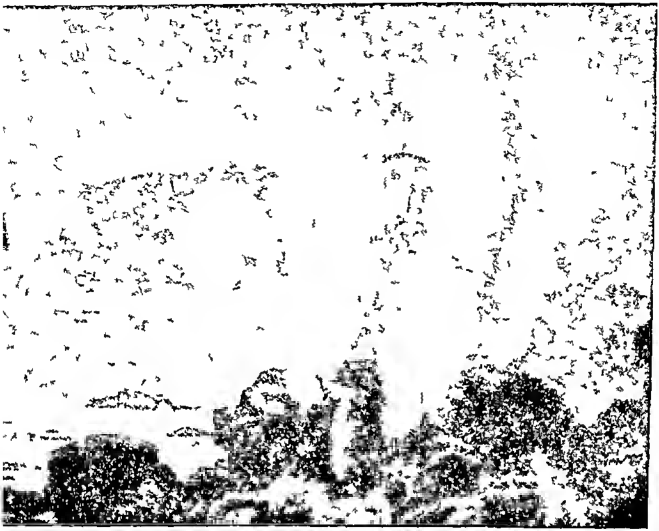


THE EARTH SEEN AS A PLANET AS WE MIGHT SEE IT IN THE HEAVENS FROM THE SOUTHERN REGIONS OF THE MOON

§ 1

A CINEMATOGRAPH PICTURE

A CINEMATOGRAPH picture of the evolution of our planet from the time when it broke away from the sun to the present time would be a spectacular affair But the *slowness of*



(Courtesy of the New York Times)
as first gaseous and then solid with the coming of atmosphere and water vapour condensing in rain falling upon the es for the young earth during millions of years was slowly changing its surface contours

world without vegetation plants or trees A monotonous smoking desert cindery under foot with no more scenery than sand dunes Here and there out of a crack comes a crawl of molten rock like very coarse grained tar hardening and blistering on its surface as it cools and creeping out in front from beneath its crust in an ugly sort of way No sun by day nor moon by night nor any stars but a thick curtain of cloud over everything and hiding the heavens And beneath the cloud a dense and dusty unbreathable air with carbonic acid gas and water vapour There was no sign of life at all nor any sound save crackling and hissing and now and then a big explosion *

The first rain to fall would surely give us a thrill in the film picture we have imagined! Falling *drops of rain on ground that had never* experienced a shower before! The sun scorched *earth a far hotter sun and a far hotter earth* than we ever knew Our film picture shows us *its rocky crust* volcanic cones bare mountains and arid plains a hot surface of earth under a hot sun then *the first rain falls*

But the first moisture did not exactly come like that No direct explanation can be given The first water possibly came from the earth itself perhaps it accumulated beneath the surface before it appeared on it It may even be that there was an original universal ocean There is no absolute certainty *

* Sir J Arthur Thomson's *Modern Science*

* *Dr* Harold Jeffreys says The earth when it had passed the turbulent period of its earliest youth

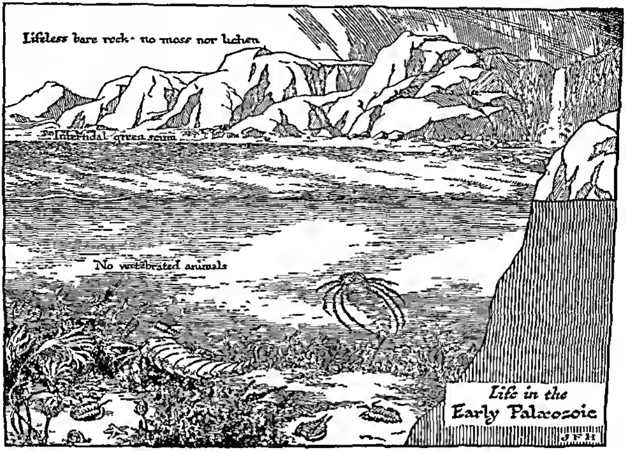


DIAGRAM OF LIFE IN THE EARLY PALÆOZOIC WORLD

We do not know how living things first arose on the earth no doubt ultra microscopic plant organisms *were first developed in the primeval waters, and other forms of life took shape becoming types of the vegetable* and animal kingdoms

In our supposed film picture—ages have passed since the first episode—we are now looking at the rigid, rocky, relatively cool surface of the earth—mountains and tablelands and depressions, a new period of earth's history begins Clouds form and storms begin to darken the heavens There are winds and rushing rivers and waterfalls, lakes and shallow seas, soil formed by the rushing torrents carrying great loads of sediment and thick mud Then slowly there come primeval vegetation and floating plants

During all this time, though we may not have noticed it, the earth has been continually shrinking, *owing to the contraction of its internal* mass and the compression of the material by the pressure of the overlying rocks, periodic shrinkages bring about the buckling up of successive series of *mountains* and new physical features Atmospheric influences, too, have been at work *disintegrating rocks and changing* the land surface The earth becomes more varied But as yet no signs of life, and we are half-way through the age of the earth, *a thousand million years have passed* If it is a "talkie" picture we are looking at we *might hear* a voice say "*It is* an interesting fact that for millions of years there

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proceeded to cool down till it was completely liquid Just how long this took is uncertain we have sufficient definite knowledge about its initial temperature size and power of radiating heat away to be able to say that it must have been *completely liquid within 5 000 years* of its formation, but the actual time was probably very much shorter Solidification would take rather longer since by that time the temperature would be lower and the radiating surface smaller thus reducing the rate of loss of heat by radiation in two ways The time of solidification might have been as long as 10 000 years Thus the earth was mainly solid within 15 000 years of its formation

was upon the earth no sound of life at all, only the noise of wind and wave, thunder and avalanche "

We might see, not the tiny amœbæ gliding in pools of water, for they are too small to see on our screen picture, but only the stirring in the waters of many minute primitive organisms, and a growing abundance of plant life No backboned animal has yet appeared

Our film picture has been running on—covering as we have said about a thousand million of years, but as yet it has not reached the geological era that saw the dawn of life on earth, *that* would be an interesting event to see, the first stirrings of life No picture can show us that except as an imaginative creation of the laboratory, for no one knows *how* life arose

We make a big jump of *a few more million years* to what the geologist calls the Palæozoic era (ancient life) On our film screen we now see a richer vegetation, a jungle growth or shrubby bush primitive forests of giant horse tails tree ferns, and club mosses, and the peopling of the seas—fishes and then wallowing amphibia venturing on to the dry land (the first creatures to use a voice), then land animals

[*From Knipe's Nebula to Man*

ANIMALS OF THE CAMBRIAN PERIOD

E.g Sponges Jellyfish Starfish, Sea lilies Water fleas and Trilobites

Another jump of millions of years and we are in the Mesozoic era (mediæval life), the cycads and low growing conifers give way to the higher flowering plants We may think of the little gasp from the audience in our cinema, when for the first time they see flowering plants, birds, the first mammals, flying dragons, and great dinosaurs—reptiles of gigantic size We listen, in our cinema, to the speaking voice " There were no gay flowers, no bright autumn tints before the fall of the leaf, because as yet there was no fall of the leaf "

Next on our screen comes the era called the Cenozoic (modern life), and our picture affords us another great thrill—we see the rise of the higher mammals and the emergence of the dawning ancestors of man In this long drawn out Cenozoic era (3-5 million years) the speaking voice is saying, ' the lands begin to bloom with cereals and fruit bearing, flowering plants, and grand hardwood forests, the atmosphere is scented with sweet odours, a vast crowd of new kinds of insects appear, and the places of the once dominant reptiles of the lands and seas are taken by the mammals Out of these struggles there rises a greater intelligence, seen in nearly all of the mammal stocks, but particularly in one, the monkey ape man ' But as we are not to follow the evolution of animal life here, but only the physical development of the earth, we shall now leave our picture house without having got a glimpse of the first tentative man Through millions and millions of years—an earth empty of mankind

Some of the more timid of the audience may have left long ago For during all this time there have been intermittent, appalling earthquakes and colossal volcanic eruptions

§ 2

Making of the Earth

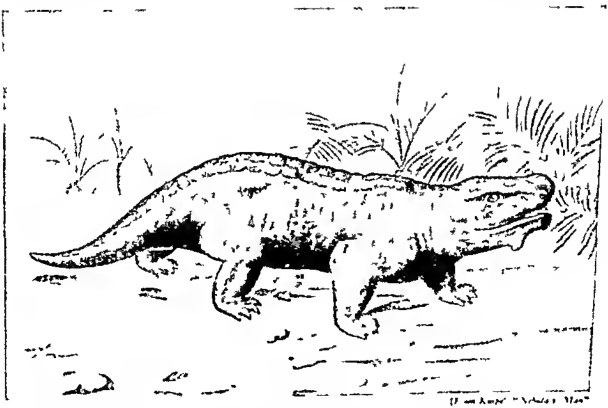
OUR picture would be too vast to include all the influences at work during the long formative period of the earth. The story would be also too complicated, and in parts it is somewhat lacking in confirmation. We have merely noted, therefore, the main outlines.

To indicate what was happening while the cooling of the earth's crust from the melting-point of rocks down to ordinary temperatures was taking place, and therefore causing violent contraction, let us quote a passage from an essay by Dr. Jeffreys; it also indicates the beginning of mountain building.

"This stage over, the outside had no more cooling to do; but the inside went on cooling and contracting. Thus the outside was left partly unsupported on its inner boundary, and had therefore to support itself by its own strength like an arch. But there is a limit to the stress of this kind that a material can stand, and after an interval of perhaps fifty million years the outer layers gave way. They crumpled up irregularly along their lines of weakness, and collapsed on the interior. Then the process recommenced, and another stage of crumpling ensued. It seems likely, both as a result of calculation and geological observation, that about six great periods of crumpling have occurred up to the present time."

Ocean and Continent

But let us turn to the formation of ocean and continent before we say more about mountain building. There is more than one theory put forward to explain the change in the arrangement of ocean and continent. It would appear that the higher continental masses and the depressed oceanic basins came into being very early in the history of the earth. Some geologists believe



[From Knipe, "Nebula to Man."]

PARIASAURUS: AN EXTINCT VEGETARIAN REPTILE OF THE TRIASSIC PERIOD

(Remains found in Cape Colony, South Africa.) Both land and water in the Mesozoic era were dominated by reptiles which attained to truly gigantic size

(This is a Map of AMERICA (and the way to CHINA as men believed it to be) which an old Pilot shewed to King HENRY VII in the year 1500

THE LOST ATLANTIS

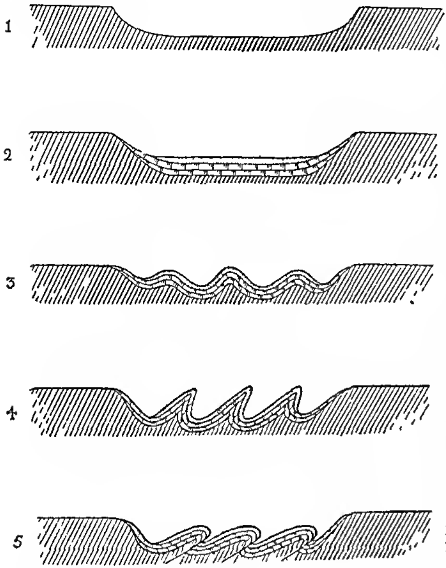
This old imaginary map shows the position of Atlantis the continent referred to by Plato in his dialogues and supposed to have disappeared in pre historic times under the waters of the ocean According to legend accepted as fact by Montaigne Buffon and Voltaire the island was once peopled by a powerful civilised and war like race who had enormous influence on the history of humanity It has been said that flocks of migrating birds annually fly to a part of the Atlantic Ocean where no land is visible and after fluttering about in dismay for some considerable time fall exhausted into the water lemmings it is also said obeying migratory instinct swim to the same spot with fatal results, but that lacks proof There is no conclusive evidence that Atlantis ever existed

that the present position of the land and water areas have been more or less permanent throughout geologic times, others believe that the oceans and lands have repeatedly changed places

We must remember that geological time covers such a vast period as to be almost beyond human comprehension, and physical and organic processes operate very slowly in nature There has been a constant shrinking of the earth, resulting in an instability of its surface and bringing about periodic changes in the relations of land and water, as well as changes in the heights and shapes of the land The arrangement of land on the globe has been, therefore, very different at different geological periods The lands have repeatedly gone down as well as up, the sum of their movements being upwards On the other hand, the lower lying land has on the aggregate moved downward, bringing about greater oceanic basins

The earth has passed through many major readjustments, there has been an inconstancy of oceans and continents, but, says Professor Gregory 'some areas in the world have remained as land throughout nearly the whole of known geological time, and perhaps through all of it ' From a study of the distribution of animals there is evidence that at one time there was some southern land connection between Australia and South America Now, some 6,500 miles of sea divide these two continents It seems that the evidence of the distribution of animals and plants proves the one time existence of continents that have broken up, and of land routes that disappeared beneath the oceans

Continents and oceanic basins may have origi-



FIVE STAGES IN THE MAKING OF A MOUNTAIN CHAIN

1 A depression forms between two continents
2 Sediments accumulate
3 The newly made rocks are folded
4 The folds become more marked
5 The folds have broken and slipped over each other

The next stage is the raising of the folded rocks out of the sea

nated as a result of the internal boiling process that prevailed during the formative era of the earth. To-day the oceans, taken as a single and continuous expanse of water, cover nearly three-quarters of the earth's surface. We shall not go into the detailed problem of the origin of oceans like, say, the Atlantic and the Pacific; the problem is still unsettled. The theory that the Pacific Ocean is the scar left on the earth where the moon had been torn off will not work, for the earth was probably in a fluid state at the time. However, the basin of the Pacific is of great antiquity. It occupies half the earth's surface, while most of the land is crowded into the other half, a thing that remains unexplained. The Atlantic is believed to date from the Mesozoic age. It is probable that the continents of Australia, India, South Africa, and South America formed part of one immense continent.

We have remarked that it is well established that in the course of time there has been a frequent interchange between land and sea areas. Nearly every part of England, to come nearer home, has undergone such changes; land areas have been submerged beneath the sea, and alternately the floor of the sea has been heaved up and become dry land. Britain, of course, was once continuous with the Continent. Mountains have sunk beneath the sea, and rocks at the bottom of the sea have been raised up and become mountains.

§ 3

Mountain Building

We have briefly mentioned the thermal contraction theory as a major cause of mountain building, but it is only one cause. Geologists classify mountains into four chief groups, each due to a different formative process. We shall not enter into details of the groups, which are

known as Block-mountains, Fold mountains, Residual mountains, and Volcanic mountains What the general reader has to image in his mind is a series of cycles of mountain building produced by various causes—the uniform uplift of parts of the earth's crust, or a vertical uplift due to the intrusion of great masses of molten rock from below among the stratified rocks, and crumpling which has given rise to "folding" and fracturing

Other causes have given rise to intense disturbance; among these causes the outburst of volcanoes and earthquakes The interested reader will find all these things graphically described in books such as Professor Gregory's *The Making of the Earth* He says, for example

"Residual mountains are so called because they are remnants of large sheets of rock, the rest of which has been removed by denudation A block-mountain or plateau is attacked by the different agencies which wear away the surface of the earth The rocks are splintered by heat and shattered by frost The gases in the air cause chemical decay of the rock constituents, and sand which is blown by the wind against cliffs and exposed rock surfaces cuts them away Rain washes the loose debris down the hillsides, and masses left unsupported slide down steep slopes as land slips The materials thus lowered into the floors of the valleys are carried away by streams, and the valleys are themselves steadily enlarged by the action of rivers and wind and sometimes by ice Hence a raised block of the earth's crust is slowly eaten away Its surface becomes jagged and irregular Valleys are cut deeply into the mass, and the ridges and summits left between them form residual mountains

"Volcanic mountains are vast heaps of lava and volcanic tuffs, piled up around volcanic vents A simple volcano usually forms a conical mountain with a central pit or crater above the mouth When volcanoes are denuded the soft loose materials are swept away, a hard core of rock solidifies in the pipe through which the volcanic materials have arisen This core is left as a hill which is known as a volcanic neck Some volcanoes pour forth vast floods of lava which bury the surrounding country beneath thick sheets of rock, the flows from many separate volcanic vents may unite into one continuous sheet, and thus a wide range of country may be buried beneath a deluge of lava The level parts form lava plains and the thicker masses or parts that have been left upraised by subsequent earth movements stand up as lava plateaus" *

The Alps

The most important folded mountains of Europe are the Alps The first steps in their formation began at the beginning of the Secondary era, when a trough-like sea formed where they now stand Throughout that incalculable length of time—the era of the first birds and mammals, of the early flowering plants, and of the giant extinct reptiles—this sea was becoming charged with enormous layers, thousands of feet thick, of sandstones, shales,

* Gregory's *The Making of the Earth*

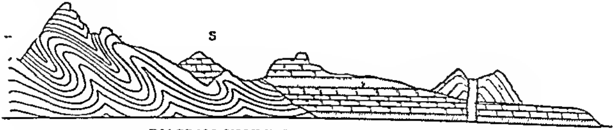


DIAGRAM SHOWING TYPES OF MOUNTAINS

The history of the imaginary country shown above in section is as follows First was formed a range of *folded mountains*, whose remains are seen on the left This range sank till the sea reached the level S, and new horizontal beds were formed The country rose again and the *horizontal beds* formed a plateau which was cut up into *relict mountains* To the left remains an original folded mountain, never completely under water, then come two relict mountains Further to the right a younger original accumulation mountain has been formed where a volcano has burst through the flat beds of the plateau

Photo A. Land through Thomson

THE MATTERHORN

This famous Alpine peak is 14,705 feet high

(Mont Blanc, the Matterhorn and others) are *formed* out of very old rocks which must have been covered by great thicknesses of younger sediments, but because of their hardness these older rocks have more successfully resisted weathering. Only here and there do the crests of the mountains correspond with the crests of the folds. The relief of the country is determined almost entirely by the sculpturing action of the streams of ice and water.

Mountains formed in this way are called *relict* mountains; they are the remains of what was once a tract of high land. And there stand to-day the Alps and the Himalayas, the mountains of upheaval, in long past ages thrust up from the sea level to heights higher than they are to-day. The *effects of glacial action and* long continued denudations are tremendous. Alpine valleys open out in every *direction, the rivers sending* the melted snows on one side into the North Sea, on another into the Black Sea, and again into the Mediterranean.

and limestones. In the next (the Tertiary) era the continent to the *south sank below the waters* of what is now the Mediterranean. This movement was the signal for intense folding to begin in the Alpine region. The folds leant over to *the north-west and formed sheets of rock lying* almost horizontally on top of each other.

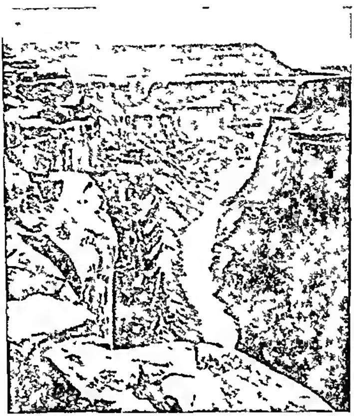
After the folding, the last step was for the crumpled rocks to be raised out of the sea to *their present height*. Immediately the forces of weathering set to work. Already, in what is geologically a relatively short time, the surface is transformed. The highest summits of the Alps

Scotland and Norway

The mountains of Scotland and of Norway are of the same type. At the beginning of geological history they arose first as a chain of folded mountains like the Alps of to-day. Several times since then, however, have they been worn down and raised up anew. Although the rocks of which they are built are among the oldest in the world, the mountains are at the same time very young, since they were raised to their present

height in the last geological period, later even than the Alps In some disturbance of the earth's crust these old mountain masses, too tough and hard to be folded, were tilted up in one vast block We can see, by the lengths of the rivers, that in general the Atlantic side of the block is shorter and steeper than the European side But in both Scotland and Scandinavia the mountains owe their shape to the action of streams of ice and water Some of the Scottish lochs fill glacier basins carved out of the earth's crust by moving masses of ice

We see, then, that there are two principal ways in which mountains are made Firstly, there are those mountains which are actually *built up*, and are known as *original* They include such types as volcanic cones, which are mere heaps of material, like a child's sand castle on the beach, and also there are the folded mountains which are portions of the earth's crust squeezed and warped like clay under the hands of the modeller Secondly, there are the *relict* mountains, which are the remains of former high land, they may be considered as monuments of weathering, cut from the solid rock



[*Smithsonian Report* 1915

The power of running water is most impressively revealed in gorges such as this of the Grand Canyon of Arizona It is two hundred and seventeen miles long averaging four fifths of a mile in depth and over five miles in width It has all been excavated out of a nearly level table land by the scour of the Colorado River and is still growing deeper year by year

Sir James Jeans, in *The Universe Around Us*, writes

Every year that passes witnesses a levelling of the earth's surface Soil which was high up on the slopes of hills and mountains last year has by now been washed down to the bottoms of muddy rivers by the rain and is continually being carried out to sea The Thames alone carries between one and two million tons of soil out to sea every year For how long will England last at this rate, and for how long can it have already lasted? In our own lifetime we have seen large masses of land round our coasts form landslides, and either fall wholly into the sea or slip down nearer to sea level Such conspicuous landmarks as the Needles, and, indeed, a large part of the southern coast of the Isle of Wight, are disappearing from our eyes The geologist can form an estimate of the rapidity with which these and similar processes are happening, and so can estimate how long sedimentation has been in progress to produce the observed thickness of geological layers

These thicknesses are very great, Professor Arthur Holmes gives the observed maximum thicknesses as follows —

Pre-Cambrian at least 180 000 feet
Palæozoic era (ancient life), 185 000 feet
Mesozoic era (mediaeval life), 91,000 feet
Cainozoic era (modern life), 73 000 feet

So long as the earth has a vast store of *internal* energy there is no danger of its being worn down into a uniform ball covered by a shallow, level floored sea As fast as the old mountains are worn away new ones arise to take their place

The hills are shadows and they flow
From form to form and nothing stands,
They melt like mists the solid lands,
Like clouds they shape themselves and go

[Will F. Ta

ARTHUR'S SEAT, EDINBURGH

A typical example of a rock mass of volcanic origin. The originally molten substance has solidified into a very durable rock able to withstand the action of the eroding agents which have removed the formerly surrounding rocks of softer nature.

§ 4

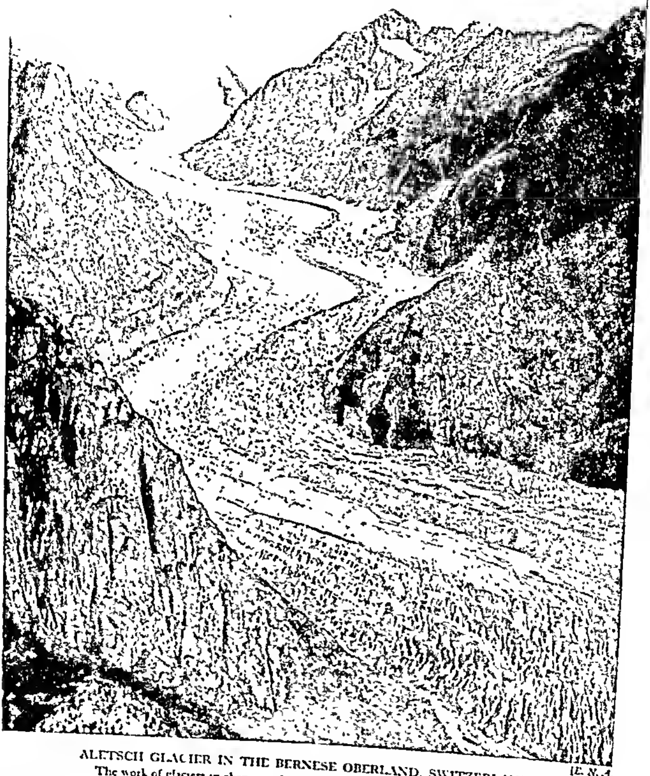
The Earth's Interior

THE reader who has read an earlier chapter of this work dealing with astronomy will understand now the difference between the earth as a new-born planet and as it is, has come to be, and how a globe that was first drawn out of the sun as a long gaseous filament of matter has become the rigid solid body we know as the earth. All that was explained in the chapter referred to and in the preceding pages of the present chapter. We have said little or nothing so far about the interior of our planet.

We have seen how the young earth began to cool and also to consolidate internally. We have seen, too, that originally the surface of the earth was probably like a mass of lava, alternately passing from crust-making to boiling over. The boiling process must have brought about a sorting of materials, the lighter materials coming to the top and the heavier sinking to lower levels. The more acid granite materials would rise and the more basic metal-containing and basaltic materials would sink.

The crust of our globe, or its outer shell, is perhaps fifty miles thick, shutting in the internal heat; below that a thick metallic shell, and last of all a central core consisting of unknown material—possibly a metal core. The centre of the earth is about 4,000 miles beneath us. For a knowledge of the conditions existing in the interior of the earth we must depend on the resources of scientific investigation.

It is probable that the rocky crust changes in its nature at a uniform rate as the temperature



ALETSCH GLACIER IN THE BERNESE OBERLAND, SWITZERLAND

The work of glaciers in changing the face of the earth is described in the text.

[E. N. A.]

rises, down to a certain depth, and beneath that there is a sudden change in the conditions Professor W Watts remarks "The physiology of the earth, however, is that of a very complex organism, and we are sure that we do not yet know all the forces internal and external acting upon it, still less their relative value and intensity, their distribution and variation in the past, or the precise records which each is capable of imprinting on the rocks of the earth crust"

We owe a great deal of our knowledge of the interior of the earth to earthquake waves and to volcanic eruptions, about which we shall speak presently

That the temperature of the interior of the earth is very high is shown by the existence of hot springs and volcanoes and by the rapid rise in temperature observed in mining operations, tunnelling, and drilling The temperature in the interior of the earth, it is reckoned, "attains some thousands of degrees centigrade, that the material of the earth, nevertheless, does not become liquid or even gaseous at such high temperatures, but is proved to be very rigid, must be attributed to the extreme pressure which packs the molecules together and robs them of their mobility Keeping this in mind while trying to ascertain the physical behaviour of bodies with increase of temperature, we may infer that the temperature in the interior of the earth must certainly remain below 9 000 degrees, in all probability it does not even reach 4 000 degrees" *

From earthquake waves it is possible to infer something of the elastic properties of the earth's substance But first let us turn our attention to volcanic eruptions, which are one of the causes of the deformation of the earth

§ 5

Volcanoes and their Effects

FROM earliest geologic times there have been periodical and widespread volcanic eruptions and disturbances They go back to the formative era of the earth, when it was very hot and molten matter broke through its outer shell When, subsequently, the interior was undergoing readjustments molten portions deep down were forced to rise as great hot tongues in the heart of mountain ranges, in many places bursting through, and giving rise to active volcanoes A volcano is an opening in the earth's crust through which this very hot matter makes its escape from the interior of the earth to the surface The downward, extending conduit is a sort of central collecting tube with spreading branches leading to local chambers in which crystallisation is going on under different temperatures and pressures Throughout geological history there have been great outbursts of volcanic activity alternating with prolonged intervals of rest

"The variations in volcanic intensity during successive geological periods," Professor Gregory says, "may be explained as due to the alternation of periods of violent disturbances of the earth's crust with periods of slight and gentle movements As the earth shrinks in size the crust sags gently downward For a time the crust may easily accommodate itself to the internal contraction, and volcanic activity is dormant As the shrinkage proceeds the crust becomes deformed and unstable, and the earth ultimately recovers stability by great readjustments of the surface During these movements the crust is fractured and parts of it sink, and at such places the pressure on the underlying rock is especially heavy This extra weight on the superheated plastic rock and the opportunity given for its escape through the fractures occasion fresh periods of volcanic activity"

Vesuvius

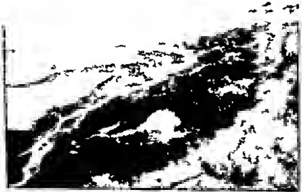
Volcanoes are closely related to the earth movements which result in the fracturing of strata and folding of the earth's crust Amongst the examples of periodically active volcanoes to-day is that of Vesuvius The earliest recorded eruption of Vesuvius (A D 79) destroyed Pompeii, leaving it "a heap of hardened mud and ashes" Pompeii, about fifteen miles south east of Naples, was at that time a flourishing and wonderful city, as excavations have proved Many of its works of art now find a home in the Naples Museum On the slopes of Vesuvius vineyards covered the

* Professor Gregory, *The Making of the Earth*

WHEN THE EARTH BOILS OVER

(1) Looking down at the boiling bottom of Mount Vesuvius crater 500 feet below the edge The central cone of the crater rises to a height of 200 feet

(2) A maelstrom of boiling lava in the world famous 2 000 feet wide crater lake of Kilauea the pit of everlasting fire as the natives most fittingly call it



(3) Stream of molten lava from Mauna Loa flowing down the mountain side in a path of cooled and hardened lava

(4) Palms falling under the attack of the seething lava pouring from the crater of Mauna Loa a 13 675 feet volcanic mountain on the island of Hawaii

(5) Red hot boulders thrown out by Mauna Loa rolling down a slope They made their way through a tropical forest

(6) One of the boulders ultimately encounters a gate and thrusts it open

[*By courtesy of the Illustrated London News*

mountain slopes and the fields for miles around. The people had warnings in a series of earthquakes that shook the country at intervals. There were other ominous signs that seemed to foretell a coming eruption.

On August 25th, A.D. 79, Vesuvius "suddenly threw up from its crater an immense column of black smoke, which, rising high in the air, spread out in the form of a huge mushroom, or, perhaps, more like the umbrella pine trees of the neighbourhood. Rapidly spreading on all sides, the smoke soon completely shut out the light of the sun, and wrapped the earth in an inky darkness, except for a red glare from columns of molten rock that rushed out of the crater."

From the dark cloud immense quantities of red hot stones, pumice, and volcanic ashes descended on the earth. At the same time there fell a deluge of rain, caused by the sudden condensation of the enormous amount of water vapour that was thrown out from the crater during the eruption. Fortunately very few of the people were killed in either of the cities of Pompeii and Herculaneum, although some bodies were found in the ruins. Most of the people escaped through the darkness and gloom, continuing to flee from the city for at least three days. So completely were these cities covered that their very existence was at last forgotten. It is true that Titus, who was then Emperor of Rome, endeavoured to clear away the ashes and rebuild Pompeii, but the task was so great that he finally abandoned it.*

Sir Ray Lankester, as an eye-witness of the most violent eruption of the nineteenth century, has vividly described Vesuvius in eruption:

The crater or basin formed by a volcano starts with the opening of a fissure in the earth's surface communicating by a pipe-like passage with very deeply seated molten matter and steam. Whether the molten matter thus naturally "tapped" is only a local though vast accumulation, or is universally distributed at a given depth below the earth's crust, and at how many miles from the surface, is not known. It seems to be certain that the great pressure of the crust of the earth must prevent the heated matter below it from becoming either liquid or gaseous, whether the heat of that mass be due to the cracking of the earth's crust and the friction of the moving surfaces as the crust cools and shrinks, or is to be accounted for by the original high temperature of the entire mass of the terrestrial globe. It is only when the gigantic pressure is relieved by the cracking or fissuring of the closed case called "the crust of the earth" that the enclosed deep-lying matter of immensely high temperature liquefies, or even vaporises, and rushes into the up-leading fissure. Steam and gas thus "set free" drive everything before them, carrying solid masses along with them, tearing, rending, shaking "the foundations of the hills," and issuing in terrific jets from the earth's surface, as through a safety-valve, into the astonished world above.

The eruption he proceeds to describe was that of 1871:

We walked up towards the Observatory in order to spend the night on the burning mountain. We found that two white-hot streams, each about 20 yards broad at the free end, were issuing from the base of the cone. The glowing stones thrown up by the crater were now separately visible, a loud roar accompanied each spasmodic ejection. The night was very clear, and a white firmly-cut cloud, due to the steam ejected by the crater, hung above it. At intervals we heard a milder detonation—that of thunder which accompanied the lightning which played in the cloud, giving it a greenish illumination by contrast with the red flame colour reflected on to it by red-hot material within the crater. The flames attributed to volcanoes are generally of this nature, but actual flames do sometimes occur in volcanic eruptions by the ignition of combustible gases. The puffs of steam from the crater were separated by intervals of about three minutes. When an eruption becomes violent they succeed one another at the rate of many in a second, and the force of the steam-jet is gigantic, driving a column of transparent superheated steam with such vigour that as it cools into the condition of "cloud" an appearance like that of a gigantic pine tree seven miles high (in the case of Vesuvius) is produced.

We made our way to the advancing end of one of the lava streams (like the "snout" of a glacier), which was 20 feet high and moved forwards but slowly, in successive jerks. Two hundred yards farther up, where it issued from the sandy ashes, the lava was white hot and running like water, but it was not in very great quantity and rapidly cooled on the surface and became "sticky." A cooled skin of slag was formed in this way which arrested the advancing stream of lava. At intervals of a few minutes this cooled crust was broken into innumerable clinkers by the pressure of the stream

* Professor Houston's *Volcanoes and Earthquakes*. In Lord Lytton's well-known novel *The Last Days of Pompeii* there is a thrilling description of the destruction of Pompeii, completely buried under twenty feet of ashes.

[I L N

EXTINCT CRATERS IN THE VALLEY OF THE VOLCANOES IN THE PERUVIAN ANDES

A remarkably fine photograph of a region where more than forty such craters were seen in as many miles

and there was a noise like the smashing of a gigantic store of crockery ware as the pieces or "clinkers" fell over one another down the nearly vertical "snout" of the lava-stream, whilst the red hot molten material burst forward to a few feet, but immediately became again "crusted over" and stopped in its progress We watched the coming together and fusion of the two streams and the overwhelming and burning up of several trees by the steadily, though slowly, advancing river of fire Then we climbed up the ash cone, getting nearer and nearer to the rim of the crater, from which showers of glowing stones were being shot The deep roar of the mountain at each effort was echoed from the cliffs of the ancient mother-crater, Monte Somma, and the ground shook under our feet as does a ship at sea when struck by a wave

As we ascended the upper part of the cone the red hot stones were falling to our left, and we determined to risk a rapid climb to the edge of the crater on the right or southern side and to look into it We did so, and as we peered into the great streaming pit a terrific roar, accompanied by a shuddering of the whole mountain, burst from it Hundreds of red hot stones rose in the air to a height of 400 feet, and fell happily in accordance with our expectation, to our left We ran quickly down the sandy side of the cone to a safe position, about 300 feet below the crater's lip, and having lit our pipes from one of the red hot "bombs," rested for a while at a safe distance and waited for the sunrise A vast horizontal layer of cloud had now formed below us, and Vesuvius and the hills around Naples appeared as islands emerging from a sea

Such is Sir Ray Lankester's vivid description He also witnessed the great eruption of the following year The great lava stream reached six miles down the mountain in the flat country below, destroying two villages—its course, narrow where it started, widened to three miles

[Courtesy of the Illustrated London News

THE WETTERHORN

Frozen dust billowing down the Wetterhorn in glittering clouds: an avalanche of snow—a fall that spreads destruction by the violent gusts of wind it causes. It is the wind and not the fall of the mass of powdery snow that works harm.

After ten days "this river, with all its waves and ripples, was turned to stone and greatly resembled a Swiss glacier in appearance A foot below the surface it was still red hot and a stick pushed into a crevice caught fire" *

The traveller can easily reach Vesuvius from Naples, a funicular railway from the base of the mountain to near the summit was opened in 1880 It takes visitors almost to the mouth of the crater As Sir Ray Lankester says in the book referred to, the varieties of volcanoes and their products make up a long story, too long to be told here There are from 300 to 400 active craters to day, grouped along certain great lines In Europe the only active volcano on the main land is Vesuvius, others like Hecla, Etna, and Stromboli (which has been constantly active since the time of Homer) are on islands The biggest volcanoes are in South America, Mexico, Java, and Japan

British Volcanoes

We in the British Isles have little experience of earthquakes and none of volcanoes It was not always so There are many records of volcanic eruption in this country indeed these islands furnish a great body of evidence regarding volcanic action in prehistoric times Many of the western islands of Scotland are partly built of volcanic rocks Central Scotland at one time was the centre of intense volcanic activity North Berwick Law marks one of the chief vents, a great volcano built up Arthur's Seat and the Castle Rock at Edinburgh so also with the Eildon Hills in Roxburghshire and the Cumbraes in the Firth of Clyde, to mention only a few The Cheviot Hills and the Lake District, ages ago were also volcanic zones, and in Wales Snowdon and Cader Idris were built up around volcanic centres

The records of volcano eruption in the past are well nigh world wide, many of them as we have seen of tremendous energy, resulting in great catastrophes

§ 6

EARTHQUAKES

WE also owe a great deal of our knowledge of the interior of the earth to earthquake waves The record of disasters and catastrophes from earthquakes is about as long as that of volcanic eruptions

From earthquake waves we are able to infer something of the elastic properties of the earth's substance From such phenomena we learn

[L. E A

NEW ZEALAND EARTHQUAKE MARCH 14th 1931

Illustrating the great damage done by the earthquake described as the most appalling disaster in the history of New Zealand The picture shows the upheaval in one of the main streets of Napier, caused by the shock

* Sir E Ray Lankester *Secrets of Earth and Sea*

tion over wide areas It is said that the great Lisbon earthquake * disturbed an area four times as great as all Europe Most earthquakes are produced by movements in the earth's crust and not as a result of volcanic eruption, they are due to a shifting of the earth crust to a sudden collapse of underground cavities, or more often to a movement of the strata along the fractures or "faults" A "fault" is a displacement by which rocks are snapped or broken across when subjected to great strain—they sink or rise to different levels

Earthquakes are felt either as vertical shocks from below upwards, as lateral shocks or as undulatory movements The most common type is the lateral or horizontal Displacement may be due to either vertical movements or to pressure from the sides

Some earthquakes are attended by subterranean sounds like the growling of thunder, the rumbling of heavy wagons and sometimes like the howling of a storm There are cases on record where such sounds have travelled for well over 150 miles Of course subterranean sounds may be heard without any earth tremor being felt

It remains to be said that there is still much uncertainty about earthquake phenomena and their cause, and a more adequate number of observations and data are required before general agreement is possible Earthquakes are most common in volcanic and mountainous regions although they may occur in any part of the world

* A full description of this and other great earthquakes will be found in Professor Houston's *Volcanoes and Earthquakes*

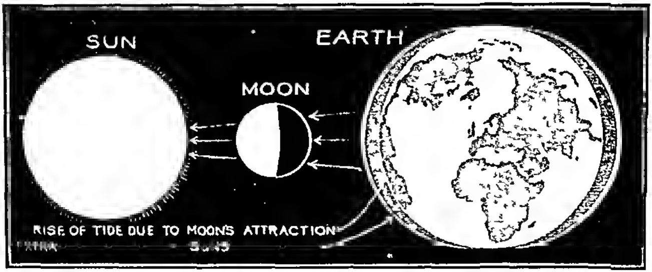
During the Great Ice Age which lasted for about 500 000 years many types of animals disappeared from the earth including huge beasts like the hairy mammoth the woolly rhinoceros the musk ox sabre tooth tiger the cave lion and cave bear

§ 7

Effects of the Ice Ages

THE ancient climates of the earth had, of course, a great deal to do with the formation of its surface, and no less with the evolution of life The subject is an important one, but we must confine ourselves to a brief reference to the Glacial Age

We speak of the Ice Age, but there were at least four periods of cold or glacial climates, differing in duration and severity and alternating with interglacial warm periods and milder climates



THE CAUSE OF TIDES

The tides of the sea are due to the "pull" of the moon and in a lesser degree of the sun. The whole earth is pulled by the moon but the loose and mobile water is more free to obey the "pull" than is the solid earth, although small tides are also caused in the earth's solid crust

J Arthur Thomson calls the sublime device of migration. Brute man appears on the scene with the introduction of the last glacial climate, and Neanderthal men probably contended with hyenas and bears and lions for the occupation of their caverns. It was perhaps the most trying time for all things endowed with life.

Professor Lull writes: "The most generally accepted single cause of the last Pleistocene glacial period is the great continental elevation which formed the Cascadian revolution, but *so far as our knowledge goes that would not* account for the successive advances and retreats of the ice mantle, with the attendant climatic variation, and some other factor such as the rhythm of solar energy must be invoked as of supplemental influence."

The last ice age probably ended about 30 000 years ago, and it is spoken of as "the end of the last ice age." We now live in a warm, equable period, emerging with fluctuations from a long phase of extreme conditions.

§ 8

SUCH, then, is something of the life story of our planet, the only planet so far as we know, where there are human beings. If there were human beings like ourselves on Mars they would see the earth reflecting the light of the sun, as *we* see the moon similarly reflecting the sunlight. The earth, like the planets Venus and Jupiter, has no light of its own. Venus and Jupiter, as we know, shine very brightly, but they only reflect the sunlight.

The circumference of the earth at the equator is 24 899 miles; its equatorial diameter is about 8 000 miles.

The mean distance of the earth from the sun is 93 million miles; travelling at a speed of more than a thousand miles a minute it goes round the *sun once in every 365 days. Its path round* the sun, year in, year out, measures about 580 million miles. It is held to its orbit by the gravitational pull of the sun; if it was not it would instantly fly off into space straight in the direction in which it was moving.

The earth revolves on its own axis once in twenty four hours. When we come to deal with the tides, which act as a kind of brake on the earth's rotation, we shall see that the earth must be gradually *slowing* down, very, very slowly. Since the earth is slowing down, it follows that it once was rotating faster. There was a period a long time ago when the day comprised only twenty hours. Going further back *still* we come to a day of ten hours; inconceivable ages ago the day must have been one of about four hours.

To go back to the earth's journey round the

sun and the moon's journey round the earth every one knows that when the moon passes between the sun and the earth there is a total or partial eclipse of the sun, and when the earth passes between the sun and the moon there is no moon to be seen, for a few minutes it is totally eclipsed The earth has interrupted the sun light that falls on the moon

§ 9

Our Planet's Future

As to what the future of the earth will be, no scientist can speak with any certainty The man who has best pictured the possibilities in the light of modern scientific knowledge is Sir James Jeans The fate of the earth is bound up with the fate of the sun, although not altogether If the sun did not fail it the present temperature of the earth, " which has about touched bottom," might remain for ever

" So far as we can at present see solar conditions can hardly have changed much since the earth was born , the earth s 2,000 million years form so small a fraction of the sun's whole life that we can almost suppose the sun to have stood still throughout it This of itself suggests that, in so far as astronomical factors are concerned, life may look to a tenancy of the earth of far longer duration than the total past age of the earth '

'The sun's loss of weight causes the earth to recede from it, and a million million years hence the earth will be 10 per cent farther away from its source of light and life A million million years hence the sun will not be radiating as much light and heat as now , the inevitable course of events will have reduced the earth's temperature by about 30° C So Sir James Jeans tells us And he adds this picture " It would be rash to attempt to predict how such a fall of temperature may affect terrestrial life, and human life in particular Given sufficient time, life has such an enormous capacity for adapting itself to its environment that it seems possible that even with a temperature 30° C lower than now, life may still exist on earth a million million years hence If so, I am glad that my life has not fallen in this far distant future Mountains and seas, which provide some of the keenest pleasures of our present life, will exist only as traditions handed down from a remote and almost incredible past The denudation of a million million years will have reduced the mountains almost to plains, while seas and rivers will be frozen packs of solid ice "

We may supplement this by a word from Professor Soddy, who has given an interesting picture of what might happen when the sun's light and heat is no longer what it is The human eye " has adapted itself through the ages to the peculiarities of the sun's light, so as to make the most of that wave length of which there is most Let us indulge for a moment in those gloomy prognostications as to the consequences to this earth of the cooling of the sun with the lapse of ages, which used to be in vogue, but which radio activity has so rudely shaken Picture the fate of the world when the sun has become a dull, red hot ball, or even when it has cooled so far that it would no longer emit light to us That does not all mean that the world would be in inky darkness and that the sun would not emit light to the people then inhabiting this world, if any had survived and could keep themselves from freezing To such, if the eye continued to adapt itself to the changing conditions, our blues and violets would be ultra-violet and invisible, but our dark heat would be light and hot bodies would be luminous to them which would be dark to us '

Jeans reminds us that accidents may happen, but in the absence of any catastrophe happening to the sun " there seems to be no reason for modifying our round number estimate of a million million years as the probable expectation, in the light of what astronomical knowledge we at present possess, of the future life of the human race on earth "

Humanly speaking then, there is nothing to worry about as to the fate of our planet Some of us might like to re visit it a million million years hence—just to see what the problems of *that* time may be And to see what our successors are like

(To be continued on page 219)

BOOK III—(*Continued from page 128.*)

THE DEVELOPMENT OF RELIGIOUS THOUGHT AND MODERN DISCOVERY

CHAPTER I (*continued*)

EFFECTS OF THE EXILE

FLAVIUS JOSEPHUS [*Ruschgit*

JOSEPHUS

The great Jewish historian and voluminous author of *Jewish Antiquities* and the *History of the Jewish War*. Of royal lineage he was born at Jerusalem in A.D. 37. His character is difficult to estimate. He was Governor of Galilee when the Jews rose in their last and fatal insurrection against the Romans. He was taken prisoner, but gained the favour of the Roman general Vespasian by prophesying that his captor would one day become Emperor of Rome. On his march on Jerusalem the Roman general took Josephus with him and (as a spectator) he was present in the Roman army at the last siege and destruction of Jerusalem (A.D. 70) which he vividly described in his great history. He was proud of his race and the old national history of the Jews but he regarded the struggle with a great power like Rome as hopeless and he personally made terms with the enemy and went to live at Rome, *where he devoted himself to literary work*. *He may* have been quite honest in the hope that he could best serve the national cause in this way, or he may only have preferred a safe life to martyrdom in a hopeless struggle. He died about A.D. 100.

§ 1

WE return, then, to complete our historical summary. The Exile lasted, at the outside, seventy years. It was Nebuchadnezzar, the Chaldean king, as we have seen, who destroyed Jerusalem (586 B.C.) and carried the Hebrews into captivity in Babylon, the capital of the second Chaldean empire. But within fifty years the turn of the conquering Chaldeans came. Cyrus, the king of Persia, who had risen "like the flash of a meteor in the eastern sky," came on the scene to dazzle the world. In his triumphant progress he conquered Babylon (539 B.C.). For three years the proud, magnificent city withstood this siege.

Once again the Hebrew exiles thought they had a deliverer, and they welcomed the Persian ruler. As a matter of fact, Cyrus, from policy or generosity, did permit such exiles as cared to

return to Jerusalem to do so. Certain chapters of *Isaiah* picture their great joy. Some preferred to remain, for in Babylon they had made their homes and some were extremely prosperous. But many went back to Jerusalem and rebuilt the ruined city on a modest scale and restored the temple. This is known as the Restoration.

The Synagogue Formed

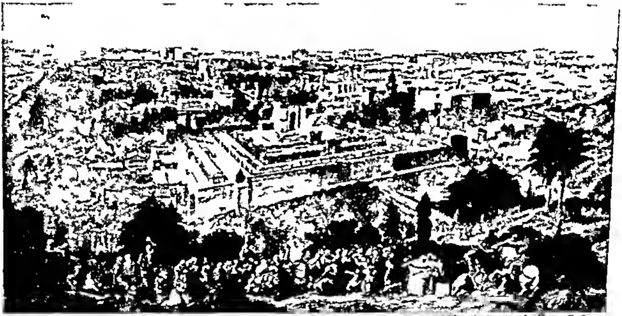
And by and by Ezra and other Jewish leaders returned to Jerusalem—*to promulgate and establish the renovated religious laws on which they had been engaged during their exile in Babylon, and which have ever since been reverenced by the Jews.*

They returned to Jerusalem and the Jewish Synagogue was formed. The religion thus organised by the returned Hebrew leaders we now call Judaism, the religion of the Jews. Under it the old Hebrew kingship was not revived. In its place a high priest at Jerusalem became the ruler of the Jews. The Jewish state was then a *religious* organisation, a church with a priest at its head.

The leaders of this church devoted themselves to the study of the ancient writings of their race still surviving in their hands. A number of the old writings, some of them mentioned in the Old Testament, had been lost. They arranged and copied the orations and addresses of the prophets, and all the old Hebrew writings they possessed. As time went on, and the service of the restored temple developed, they arranged a remarkable book of a hundred and fifty religious songs—the hymn book of the second temple, known to us as the Book of Psalms. For a long time, indeed for centuries, these various Hebrew books, such as the Law, the Prophets, the Psalms, and others, circulated in separate rolls, and it did not occur to any one to put them together to form one book.

It was not until Christian times that the Jewish leaders put all these old writings of their fathers together to form one book. Printed in Hebrew, as they were originally written, they form the Bible of the Jews at the present day. These Hebrew writings have also become a sacred book of the Christian nations. When translated into English, it is called the Old Testament. (Breasted)

We shall not go on to recount the further



[After the painting by Henry C. Selous

JERUSALEM IN HER GRANDEUR

Jerusalem, the holy city of the Jews in the days of its greatest prosperity and ancient glory. Surrounded by walls, it was built on four hills two thousand feet above the Mediterranean. It has been besieged, overthrown and rebuilt many times, and the present city stands on the ruins of its ancient predecessors.

[R schgitz

THE DESTRUCTION OF JERUSALEM BY THE ROMANS (A D 70)

The four years siege was one of the most terrible in history the Jews fired by a holy zeal holding the magnificently fortified city to the very last Finally it fell to Titus the Jews died by thousands from famine and plague and in the last terrible massacre when the city was razed to the ground

political trials and tribulations of the little Jewish state after the Restoration It was never entirely free from internal turmoil and rivalries Trouble came, too, from outside Notably it suffered a new persecution at the hands of Antiochus the Seleucid monarch, the observance of Jewish practices was forbidden, the Temple was again dismantled and pillaged By and by a champion appeared in the person of Judas Maccabeus, who secured independence for the little state until Rome came on the scene Then in 40 B C the government passed into the hands of Herod the Great There were fresh persecutions and finally an end of all things In A D 70 Jerusalem, at the hand of Titus experienced another siege, which ranks for horror and bitterness with any siege in history The cup of Jewish suffering was full Their national humiliation was complete Their despondency profound

"The Years of Silence"

We must turn again to see what effect this had on the religious conception of the Jews Until quite recent years Biblical scholars were faced by an unbridged gap of three hundred years between the Old Testament and the New Testament record From the establishment of Judaism with a high priest at Jerusalem, and the Jewish state a *religious* organisation, until the advent of Christianity, three centuries elapsed Judaism had become the religion of a sacred book the Jewish State a religious organisation with a high priest at its head The Law had put an end to prophecy The age of the prophets gave place to the priestly code, and the religion of the Jews was gathered up into the temple worship of Jerusalem

Now, this had a remarkable sequel in Jewish history, splitting up Jewish thought into two separate channels as we shall see Canon Charles says Owing to the efforts of Ezra and his spiritual successors the law came to be regarded as the complete and last word of God to man When this view of the law became

(Cour esy of the Amer an Colom Jeru a em

THE CHURCH OF THE HOLY SEPULCHRE JERUSALEM

Th s Church is a collect on of bu ld ngs ma nly of mediæval origin only a few fragments of the orig nal church built by Constant ne the Great having survi ed A l ttle Greek chapel co ers the tomb but the authenticity of the s te has been much d sputed Various branches of the Church hold property in the surround ng bu ld ngs and have rights in the rotunda and the Sepulchre a position which has led to much b tterness at various times

dominant it is obvious that no man however keenly he felt himself to be the bearer of a divine message to his countrymen could expect a hearing What then happened ?

Sel olars used to speak of the interval between the Old Testament and the New Testament as the years of Silence It is only within recent years that Biblical scholars have discovered that there were no such years of silence A vast literature called the Apocalyptic writings has been discovered This ser es of writings or books was the work of pseudonymous writers pseudonymous because of the reason we have stated The Law had closed the mouth of prophets If seers and new propl ets had any thing to say they had to resort to anonymity

We shall see presently how Jewish thought came to diverge into two distinct streams There was the legal teaching based upon the appl ca tion of the Mosaic law, the type of teaching that at a later date was embodied in the Talmud the authorised form of Judaism on the other hand there was the rise of the mystic Apocalyptic writers with other conceptions than the law, conceptions wh ch gave a new turn to relig ous views and which transformed the doctrine of the Kingdom

We are dealing with the period of relgio development between the Old and the Ne Testaments It was the period of Apocalypt literature a l terature or series of books as w have said by unknown writers written und

THE APOTHEOSIS OF HOMER

After the painting by J. A. Ingres

To face page 180]

assumed names which are nearly always *the names of various ancient worthies in Israel* (such as Ezra, Baruch, Daniel, Jeremiah, Isaiah, Moses, Enoch, etc)

Canon Charles writes "This literature was written probably for the most part in Galilee, the home of the religious seer and mystic Not only was the development of a religious but also of an ethical character In both these respects the way was prepared by this literature for the advent of Christianity A study of the New Testament makes it clear that its writers had been brought up in the atmosphere created by these books and were themselves directly acquainted with many of them Owing to these religious thinkers and visionaries the hopeless outlook of the faithful individual in the Old Testament was transformed into one of joy The expectation of the Old Testament saint was an everlasting existence in the unblessed abode of Sheol or Hades This expectation was transformed by this school of writers into the hope of a blessed immortality"

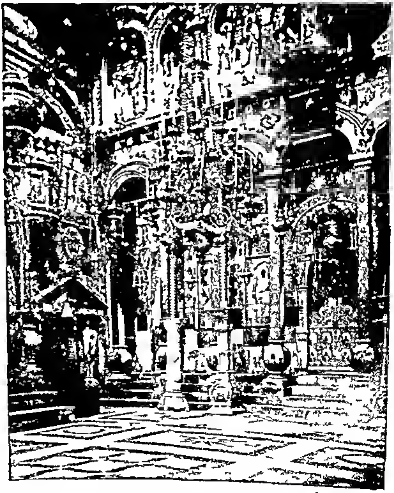
In passing it may be noted that at this time adherents of the Orphic mystery cult of Greece were travelling far afield even into Judea spreading the strange worship of Greek divinities, and frenzied rites and prophesyings What this ecstatic religion meant we shall see when we come to consider the religion of Greece

An Important Period

We are, then, almost at the eve of the foundation of Christianity, the age of the Apocalyptic writers This period is important, on this hinges controversy

It is here that the *historical* and the *theological* points of view regarding Christ come into conflict To simplify the story we shall *not* go into detailed reference to what is called the *Apocalyptic eschatology* prevalent at the time preceding the birth of Christ The promise or the idea of a national Messiah now disappears or partly disappears The term *Apocalyptic* is given to a type of literature on account of its peculiar *form*, that is, revelation through visions expressed in a particular kind of symbolism (The *Book of Revelation* and much of *Daniel* are examples) *Eschatology* is a name which more properly attaches to the *matter* of the literature—the description of the "last things," the end of the present world order, and the hereafter

"This Apocalyptic literature (as one writer puts it) essayed a philosophy of religion and of history, seeking to penetrate behind events to their divine purpose, and embracing past, present, and future in a single supernatural scheme, culminating in the advent of the divine kingdom, the last judgment, and the resurrection



[Photo E N A

INTERIOR OF THE CHURCH OF THE HOLY SEPULCHRE, JERUSALEM

of the righteous to a blessed future life It showed millenarianism is the product of Jewish apocalyptic It furnished an imaginative outlet for the patriotic spirit among the Jews, who were too weak to realise their national aspirations in action The importance of Jewish apocalyptic for an understanding of the religious environment under which Christianity appeared is very great, and its influence on Christian eschatology proved deep and lasting, *e g* the conceptions of the final judgment, of heaven, and of everlasting punishment have their source in Apocalyptic literature "

Another writer remarks "The eschatological question, if not the most difficult and disturbing is at any rate the most living issue in New Testament criticism, and at the present time attracts more general interest than any other subject connected with Biblical studies "

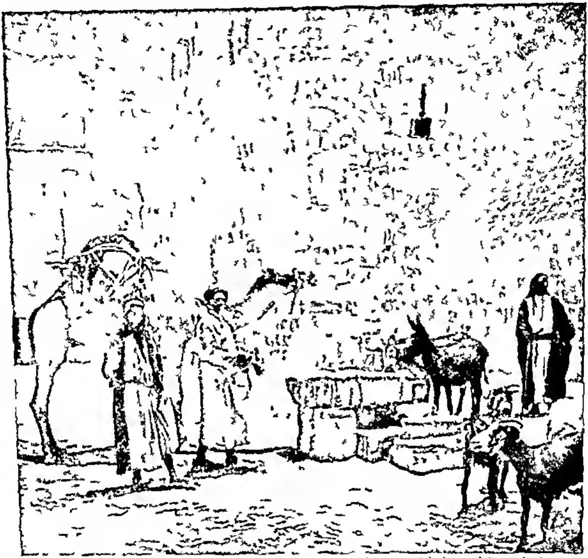
Describing this, Canon Streeter says, ' The vivid directness of the ancient prophet is replaced by a complicated symbolism, to our modern taste fantastic and bizarre Unheard of tribula tions, angelic and demonic conflicts lead up to catastrophes shaking earth and heaven The dead shall rise to judgment and the righteous people of God both those newly risen and those who had not experienced death, in bodies glorified and transformed shall enter into a life of blessed ness in a New Jerusalem on a renovated earth '

We have a lucid description of this period in Professor De Burgh's *The Legacy of the Ancient World* The doctrine of the Kingdom was transformed in a striking manner in the two

[*Courtesy of the American Colony Jerusalem*

THE JEWS WAILING PLACE

Part of the western wall of the Temple area This is the great show place of the Jerusalem Jewry as the Temple is for the Moslems and the Church of the Holy Sepulchre for the Christians Every Friday afternoon and after morning service on Sabbaths and holy days the Jews assemble in a picturesque crowd to bewail their fallen fortunes Probably the origin of this was the ancient privilege granted the Jews of purchasing a portion of the ancient walls of the city



[Courtesy of the National Geographic Magazine

A SCENE IN BETHLEHEM TO DAY

Camels still come to Bethlehem the place where Jesus was born Donkeys much in use to pack light burdens are drinking at the centuries old rock trough on the cistern mouth

centuries before Christ Up to this time but few of the Jewish people had a belief in resurrection The traditional view of the soul for the Hebrews, as for other races was crude and associated with the cult of ancestors, and devoid of ethical significance 'There is here no question of personal immortality or of moral retribution after death We have seen how thinkers like the author of Job struggled vainly to find an answer to the problem It was the stress of persecution under Antiochus that forced the belief in resurrection upon the mind of the Jewish people It had been confined to a small minority, influenced possibly by contact with Zoroastrian ideas The passages in the Old Testament that allude to it are few and late"

To the apocalyptist the position of the Jews is hopeless He finds neither freedom nor glory in this life or upon this earth The main object of these writers was to console the godly in their oppression and to strengthen their faith in the righteousness of God"

As the first century (B C) drew on, a further and far reaching development made its appearance "The conviction grew that this earth was unworthy to be the scene of the consummation of the Kingdom, that at the coming of the Messiah, or at the close of his earthly reign,

Jehovah would create a new heaven and a new earth, and that after a final judgment, the soul of the righteous Israelite would pass to an eternal life in the heavenly Kingdom" *

Recent Discovery

This kind of Apocalyptic literature was abundant just prior to the time of Christ Much of this literature is of comparatively recent discovery Canon Streeter tells us that its recovery and historical interpretation has been one of the greatest achievements of modern Biblical scholarship Many of these Apocalyptic writers make no mention of the Messiah The hope of the restoration of Israel by direct divine intervention did not need the ideal king dreamed of by the earlier prophets But, as Streeter says, the fact that inspired prophets had foretold such a personal deliverer, a king, could not be ignored We have recorded a vision of "one like unto a Son of Man coming with the clouds of heaven" In Enoch this "Son of Man" "is interpreted as a supernatural being, who with his angels shall confound the kings of the earth, sit on the throne of God, judge the world, and in general be God's agent in introducing the new era of the Apocalyptic hope"

As Streeter reminds us, all this is of much importance "This conception of the Messiah as Son of Man, that is, as a pre existent super natural being destined to be manifested at the close of history to usher in the new era, is by far the most important if we are to understand the general outlook of the original disciples and of the writers of the New Testament But it did not displace either the name or the conception of the ideal Son of David"

We have now a new conception of the kingdom of God "The main object is clear The great prophets of Israel had prophesied the glorious future of the chosen people of God, and yet the Jew was everywhere trampled underfoot Hence, to console the Jew for his present distress, a picture was revealed of future greatness, of the dawn of a new earth and a new heaven, while *a definite idea of immortality* which had been wanting in the earlier Hebraic literature was slowly evolved"

The Apocalyptic Writings

The prophets, as we saw, had all died away The claim of John the Baptist to prophetic inspiration, says Canon Streeter, broke the silence which had lasted for more than three hundred years As we have said, it is only in recent years that scholars have discovered this vast Jewish apocalyptic literature previously unknown From some of these oracles, the Book of Enoch, or the Book of the Secrets of Enoch, written in Egypt, many obscurities in the New Testament have been mitigated, many phrases are reproduced practically verbally in the Gospels —"Blessed are the peacemakers," "Swear not at all," etc These books were known and were quoted from, and some of their ideas borrowed, by New Testament writers No one, Professor Peake says, can answer the question, "What Bible was recognised by Jesus and the New Testament writers?"

Conflicting Opinions

Here there is conflicting opinion While one scholar regards apocalyptic ideas as "an evil inheritance which the Christians took over from the Jews," another regards "the vast services of apocalyptic not only to Judaism but still more to Christianity, and now steadily coming into recognition", another authority thinks "that prophecy and apocalyptic represent two contrasted conceptions of the nature of revelation, two ideas of the supernatural, two estimates of the present life, two theologies, almost two religions"

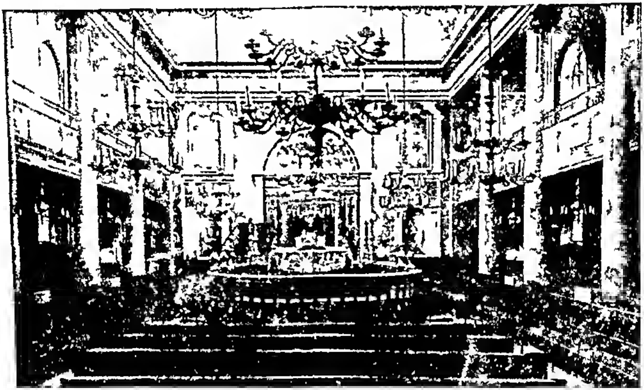
One thing is clear enough Christianity did not leap full grown into life at the beginning of the Christian era, "unbeholden" to the so called years of silence "Such an idea has been rudely shattered by the research of recent years" But we shall not anticipate what more has to be said on this subject in a later chapter

* 'Nowhere in the Jewish writings of the first century B C or the first century A.D is any trace discoverable of the admission of the Gentiles to the kingdom

§ 2

Conclusion

IN relating the *history* of these events and religious movements in Jewish history, we have done all we set out to do It is no part of a work like this to discuss theological and ecclesiastical theories, except to relate their historical development and setting which will be done in due course The facts from the point of view of secular history are all that we have attempted to deal with here Modern Biblical scholars are ready to admit that Jesus of Nazareth cannot be divorced from his environment, that he lived during the years when the later Jewish "apocalyptic" school and apocalyptic writings were widely known and well known to him that eschatology or the doctrine of the last and final things, played a large part in the ordinary conceptions of the world around him, that he was deeply influenced by this later Jewish apocalyptic Messianism In a word, it is hardly possible to dissociate his personality from the broad apocalyptic conceptions prevalent in his age He made use of both apocalyptic language and images Modern scholars are ready to admit all that, Dr Matthews, the Dean of St Paul's, writes "The religious experience of Jesus not only expressed itself in, but flowed into, moulds which were provided by the thought and imagery of his race and time"



INTERIOR OF THE GREAT SYNAGOGUE LONDON
Built in 1790

Such, then was the Jewish religious background in the years of political despair and Messianic hope just prior to the dawn of the Christian era It was the final phase, so far as our present narrative goes

We have finished with Judaism Jesus was born a Jew but the Jews rejected him as the promised Messiah Judaism and Christianity went their several ways To discuss the subsequent history of the Jews and Judaism would take us far beyond the limits set in this Outline

Judaism has never defined its creed, it has certain articles of faith, but no official council has ever laid down what a Jew should believe

The Jews never had a Council of Nicæa They believe in the unity of God "The Jews do not believe in the Jesus who is the Christ of theology Orthodox Jews who do believe in the coming of a Messiah do not believe that Jesus was the Messiah And Liberal Jews do not believe in any personal Messiah, past or present" (Rabbi Israel Mattuck) The Liberal Jews believe in a Messianic age, in the emergence of a better and a righteous world, "that will come through the efforts of humanity under the guidance of God The universe is his incarnation The Jews do not and cannot believe in Christ the Incarnation of God" God is One Mr C G Montefiore, a leading Jewish scholar and writer, writes ' Judaism and Christianity both believe in the Divine Unity But Judaism holds that the Christian doctrine of the Trinity is inconsistent with a proper conception of the Unity of God, to Judaism the doctrine of the Trinity is false

But the fundamental issue is the plain and straightforward one was he, or was he not, the Messiah? The Jews said that he was not And this is still the opinion of Jews to-day The modern educated Jews to day would no longer hold that Jesus was a deliberate deceiver, but only that, if he claimed to be Messiah, he was self deceived"

In what concerns religion as distinct from organised institutionalism, the Jew and the Christian have far more in common than is often supposed And "modernism" is a living force in both the Jewish and Protestant faiths Both have had a long and chequered history Both have experienced growth If we can say there is no universally agreed creed of essentials in Christianity, neither is there of Judaism There are Christianities, and there are Judaisms As Mr Montefiore says "There have been, and there are, many Judaisms and many Christianities, but where is, and wherever has there been that elusive, gossamer, ethereal thing which we could call Judaism or Christianity, pure and simple, in the singular?" But we are anticipating

For the time being, to preserve historical continuity, we pass from all this to consider the contemporaneous religious history of the Greeks For about a thousand years the religion of ancient Greece moves contemporaneously with the Hebrew, they move on parallel lines, but quite distinct in their conceptions In the first century of the Christian era, however, there is mingling of the waters The Christian religion begins to absorb a great deal of the pagan religion, of the Mystery religions, and the philosophy of the Greeks It is a profoundly interesting study with a direct bearing on the religious thought of centuries to come and right down to our own day All that is the subject of a later chapter in this work

CHAPTER II

THE RELIGION OF ANCIENT GREECE IN CONTRAST WITH THE HEBREW

[The following chapter, like the previous one, is based on the works of various authorities whose ideas, and sometimes language, have been closely followed]

WE have traced Hebrew religion down to a momentous point in history, to the dawn of the Christian era It is the parting of the ways for those Jews who embraced Christianity and those, the vast majority, who rejected it and for whom Judaism remained the Jewish faith It was more than that We shall see also the passing of much of the pagan religion of ancient Greece into Christianity, along with much of Greek philosophy Not altogether, and not all at once The gradual assimilation of certain elements of Hellenism by Christianity was a matter of two or three centuries

The analogy between the development of the primitive religion of the Hebrews into monotheism and the idea of One God, and a like development of the pagan religion of ancient Greece is striking And it was a contemporaneous development, but on quite different lines

[Mansell

"A READING FROM HOMER" BY SIR LAWRENCE ALMA TADEMA

To the ancient Greeks Homer and the Homeric legends was like a Bible every Greek knew them by heart and they supplied plots to the great Greek dramatists The greatness of the *Iliad* and the *Odyssey* is to be found in the spirit and character of the heroes

§ 1

IN previous chapters we have traced the evolution of the Hebrew nation and Hebrew religion, let us do the same, but much more briefly, with the Greeks Then we shall see the meeting of the waters in the first century of the Christian era, or, rather we should say the gradual mingling of the religious streams of Greek religion and of Hebrew religion with Christianity The reader must understand that all we are attempting is an analogy We are only selecting from Greek history what is germane to our purpose of comparison, glancing at certain periods and phases of Greek beliefs, Greek thought, and Greek philosophy—to contrast them with the Hebrew

The Hebrews invented for themselves a fanciful ancestry So did the Greeks Professor Bury, in his *History of Greece*, writing on the Greek reconstruction of their own early history, writes "We must now see what the Greeks thought of their own early history Their construction of it, though founded on legendary tradition and framed without much historical sense, has considerable importance, since their ideas about the past affected their ideas of the present Their belief in their legendary past was thoroughly practical mythic events were often the basis of diplomatic transactions, claims to territory might be founded on the supposed conquests or dominions of ancient heroes of divine birth * At first, before the growth of historical curiosity, the chief motive for investigating the past was the desire of noble families to derive their origin from a god For this purpose they sought to connect their pedigrees with heroic ancestors especially with Heracles, or with the warriors who had fought at Troy

The later Homeric poets must have contributed a great deal to the fixing of the mutual relations of legendary events, but it was the poets of the school of Hesiod in the eighth century B C who did most to reduce to a historical system the legends of the heroic age Their poems are lost, but they were worked up into

* Professor Bury adds Grote has illustrated this from our own history The belief in the descent of the kings of England from Brute the Trojan was still robust in the seventeenth century It figured in a state document drawn up in A.D 1301 to uphold the rights of the English crown in the dispute with Scotland Rome as we know invented an ancestry for herself For this inventing of ancestries the Hebrews, if the most drastic, were not alone

still more complete and elaborate schemes by the prose logographers or 'story writers' of the sixth and fifth centuries."

The probable ancestry of the Greeks is a subject about which historians to-day know more than the ancient Greeks themselves did. Breasted pictures the coming of the nomad Greeks from the broad pastures along the Danube into the Greek peninsula in almost the same language as he pictures the Hebrews drifting with their flocks and herds into Palestine. "Driving their herds before them, with their families in rough carts drawn by horses, the rude Greek tribesmen must have looked out upon the fair pastures of Thessaly, the snowy summit of Mount Olympus, and the blue waters of the Ægean not long after 2000 B.C.* . . . From their old wandering life on the grasslands they carried with them the loose groups of families known as tribes, and within each tribe an indefinite number of smaller groups of more intimate families called 'brotherhoods.'"

The various branches of the Greek race were related, and in course of time they were known by the common name of Hellenes, which denotes all settlers and strangers of the same race. They had a common language although they spoke various Greek dialects. "Bound together by ties of custom, religion, language, and common traditions, the Greeks gained a feeling of race unity which set them apart from other races. They called all men not of Greek blood 'barbarians,' not originally a term of reproach for the non-Greeks.† Then the Greek sense of unity found expression in the first all-inclusive term for *themselves*. They gradually came to call themselves 'Hellenes,' and found pleasure in the belief that they had all descended from a common [fictitious] ancestor called Hellen. It should be clearly understood that this new designation did not represent a Greek *nation* or state, but only the group of Greek-speaking peoples or states, often at war with one another."‡ Almost a complete parallel with the Hebrews in Mesopotamia.

Hellen is the name of a mythical hero, placed in Thessaly because the Hellenes of Homer lived in Thessalian regions. Hellen was variously represented as the son of Zeus and the son of Deucalion. "The fictitious ancestor Hellen became the forefather of the whole Greek race." (Bury.) But for the most part the Greeks' connection with Hellen and his sons was manufactured. Hellas became the name of ancient Greece.

§ 2

THE BEGINNING OF RELIGION

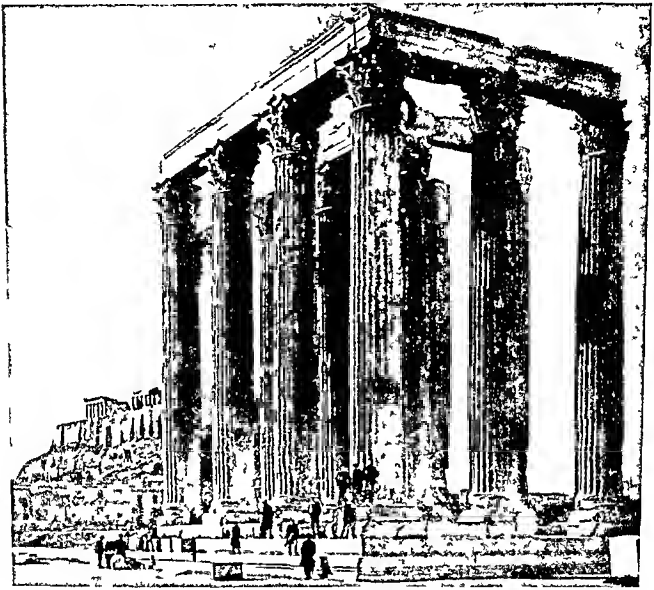
OF the earliest stage of Greek religion, further back than the time at which we are beginning, Gilbert Murray says, "It is a stage to which our anthropologists and explorers have found parallels in every part of the world. In some ways characteristically Greek, in others it is so typical of similar stages of thought elsewhere that one is tempted to regard it as the normal beginning of all religion, or almost as the normal material out of which religion was made. There is also an element of fascination in the study of these 'beastly devices of the heathen,' at any rate as they appear in early Greece, where each single 'beastly device' as it passes is somehow touched with beauty and transformed by some spirit of upward striving. . . . It was not until somewhere about the sixth century B.C. (some would put it later) that the practice of human sacrifice became repellent to the Greek conscience."

The Olympian Gods

We know how much the Greeks were influenced as to their legendary past by the Homeric poems, which are compounded of many different legends and poems. The Homeric period is called the Olympian stage. The later Greeks got their gods from Homer. Where did the Olympian gods come from? Gilbert Murray's racy answer is this:

"The Olympians are the mountain gods of the old invading Northmen, the chieftains and

* The time of Abraham.
† There is an extremely close parallel with the use of the term *Goüm* or Gentiles by the Hebrew writers.
‡ Breasted in his *Ancient Times*.



[Mansell

TEMPLE OF ZEUS AT ATHENS

This majestic temple is still imposing in spite of the fact that only fifteen of its Corinthian columns remain standing. It was begun in 530 B.C. but finished only in A.D. 129 by Hadrian. It is the largest Greek temple known. In the background is the Acropolis. Zeus was the chief of the Olympian gods, the supreme god. (See page 192.)

princes, each with his loose following of retainers and minor chieftains, who broke in upon the ordered splendours of the Ægean palaces and, still more important, on the ordered simplicity of tribal life in the pre-Hellenic villages of the mainland. Now it is a canon of religious study that all gods reflect the social state, past or present, of their worshippers. From this point of view what appearance do the Olympians of Homer make? What are they there for? What do they do, and what are their relations one to another?

The gods of most nations claim to have created the world. The Olympians make no such claims. The most they ever did was to conquer it. Zeus and his *comitatus* conquered Cronos and his, conquered and expelled them—sent them migrating beyond the horizon, Heaven knows where. Zeus took the chief dominion and remained a permanent overlord, but he

still more complete and elaborate schemes by the prose logographers or 'story-writers' of the sixth and fifth centuries"

The probable ancestry of the Greeks is a subject about which historians to-day know more than the ancient Greeks themselves did Breasted pictures the coming of the nomad Greeks from the broad pastures along the Danube into the Greek peninsula in almost the same language as he pictures the Hebrews drifting with their flocks and herds into Palestine "Driving their herds before them, with their families in rough carts drawn by horses, the rude Greek tribesmen must have looked out upon the fair pastures of Thessaly, the snowy summit of Mount Olympus, and the blue waters of the Ægean not long after 2000 B C * From their old wandering life on the grasslands they carried with them the loose groups of families known as tribes, and within each tribe an indefinite number of smaller groups of more intimate families called 'brotherhoods'"

The various branches of the Greek race were related, and in course of time they were known by the common name of Hellenes, which denotes all settlers and strangers of the same race They had a common language although they spoke various Greek dialects "Bound together by ties of custom, religion, language, and common traditions, the Greeks gained a feeling of race unity which set them apart from other races They called all men not of Greek blood 'barbarians,' not originally a term of reproach for the non Greeks † Then the Greek sense of unity found expression in the first all inclusive term for themselves They gradually came to call themselves 'Hellenes,' and found pleasure in the belief that they had all descended from a common [fictitious] ancestor called Hellen It should be clearly understood that this new designation did not represent a Greek *nation* or state, but only the group of Greek speaking peoples or states, often at war with one another' ‡

* The time of Abraham

† There is an extremely close parallel with the use of the term *Goim* or Gentiles by the Hebrew writers

‡ Breasted in his *Ancient Times*

Almost a complete parallel with the Hebrews in Mesopotamia

Hellen is the name of a mythical hero, placed in Thessaly because the Hellenes of Homer lived in Thessalian regions Hellen was variously represented as the son of Zeus and the son of Deucalion "The fictitious ancestor Hellen became the forefather of the whole Greek race" (Bury) But for the most part the Greeks' connection with Hellen and his sons was manufactured Hellas became the name of ancient Greece

§ 2

The Beginning of Religion

Of the earliest stage of Greek religion, further back than the time at which we are beginning, Gilbert Murray says, "It is a stage to which our anthropologists and explorers have found parallels in every part of the world In some ways characteristically Greek, in others it is so typical of similar stages of thought elsewhere that one is tempted to regard it as the normal beginning of all religion or almost as the normal material out of which religion was made There is also an element of fascination in the study of these 'beastly devices of the heathen,' at any rate as they appear in early Greece, where each single 'beastly device' as it passes is somehow touched with beauty and transformed by some spirit of upward striving" It was not until somewhere about the sixth century B C (some would put it later) that the practice of human sacrifice became repellent to the Greek conscience

The Olympian Gods

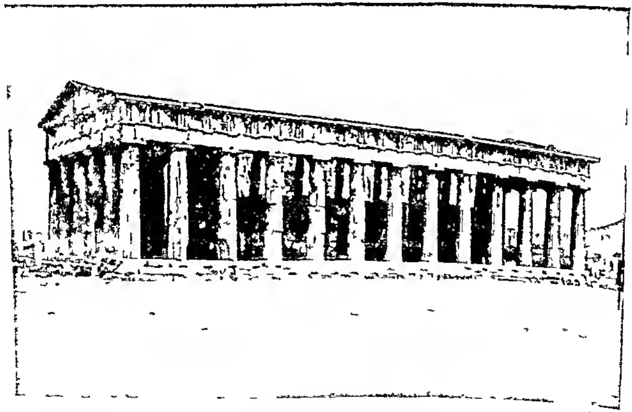
We know how much the Greeks were influenced as to their legendary past by the Homeric poems which are compounded of many different legends and poems The Homeric period is called the Olympian stage The later Greeks got their gods from Homer Where did the Olympian gods come from? Gilbert Murray's racy answer is this

"The Olympians are the mountain gods of the old invading Northmen, the chieftains and

ment This date marks the end of the dark age in Greece, which we have just mentioned About this time, we may note, the *Hebrews* had reached the point when the united kingdom ruled over by David, and then by Solomon, had split in two The Hebrew national troubles which were to end in disaster were beginning

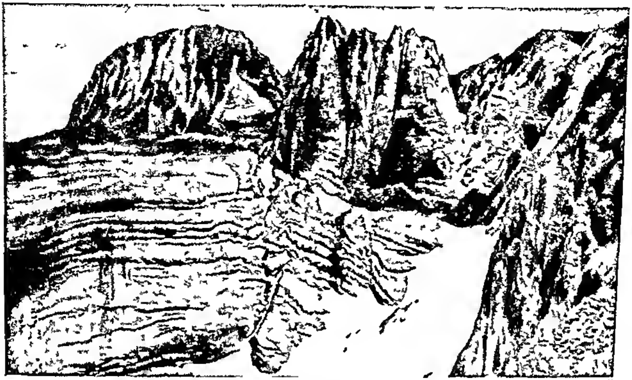
When the curtain begins to rise on recorded Greek history in the eighth century B C, the patriarchal monarchies of which we read in Homer are disappearing and republics are taking their place There is no Old Testament of Greek history from which we can piece events Bury writes "It is a transformation of which the actual process is hidden from us, and we can only guess at probable causes, but we may be sure that the deepest cause of all was the change to city life. The revolution was general, the infection caught and spread In some cases gross misrule may have led to the violent deposition of a king; in other cases, if the succession to the sceptre devolved upon an infant or a paltry man, the nobles may have taken it upon themselves to abolish the monarchy" We see the rise of various state republics, the nobles become rulers, political machinery comes into play, and traditions which guided usage begin to assume the form of laws

About the same time that Solon, the great lawgiver, in the middle of the seventh century is framing a new code of civil laws for the Athenian State, the Hebrew Ezra (in exile in Babylon) is framing the religious Deuteronomic code for the Jews, of which we have spoken in a previous chapter In both cases the law (in one case the civil, in the other the religious) had been partly a matter of oral tradition While Solon, stirred by the loss of Salamis, is rousing the Athenians to hold fast to their national honour, and proclaiming a new constitution to improve the evil



THE TEMPLE OF THESEUS [Alinari

The best preserved Greek temple in the world There is no record of its origin but its style suggests that it was built about the same time as the Parthenon It has been known as the Theseum because some of its sculptures represent the exploits of Theseus but its identification with the temple of Hephaestus and Athena is practically certain



[Man ell

THE PEAKS OF MOUNT OLYMPUS

The earl est Greek deit es were supposed to dwell on Mount Olympus the h ghest peak of which reaches 9 800 feet The Olympian gods represented the earliest phase of Greek rel gion preced ng the age of mystery rel gions and mystical rel gion To the Greeks these gods were ideal sed super human beings and they gave them various names such as Zeus Apollo Athena etc

apportioned large kingdoms to his brothers Hades and Poseidon, and confirmed various of his children and followers in lesser fiefs Apollo went off on his own adventure and conquered Delphi Athena conquered the Giants She gained Athens by a conquest over Poseidon, a point of which we will speak later

' And when they have conquered their kingdoms what do they do? Do they attend to the government? Do they promote agriculture? Do they practice trades and industries? Not a bit of it Why should they do any honest work? They find it easier to live on the revenues and blast with thunderbolts the people who do not pay They are conquering chieftains, royal buccaneers They fight, and feast, and play, and make music, they drink deep, and roar with laughter at the lame smith who waits on them They are never afraid, except of their own king They never tell lies, except in love and war"

Just as devout Hebrews were taught much about their God by tales of him in the narratives of their forefathers, so Homer became the first religious teacher of the Greeks Like that of the Hebrews the religion of the Greeks was of slow growth, progressing gradually from a low level to higher and nobler planes

§ 3

Greek and Hebrew Parallels

HOMER is supposed to have lived round about 850 B C but the *Iliad* and the *Odyssey* relate traditional events of a previous age Between the events of the *Iliad* and the dawn of sober Greek history there intervened the dark age,' a period about which little is known of what was happening in Hellas An earlier civilisation had disappeared It is called the Heroic Age

Let us take Homer's date, the ninth century B C, as the starting point of our comparison of Hebrew and Greek parallel religious develop-

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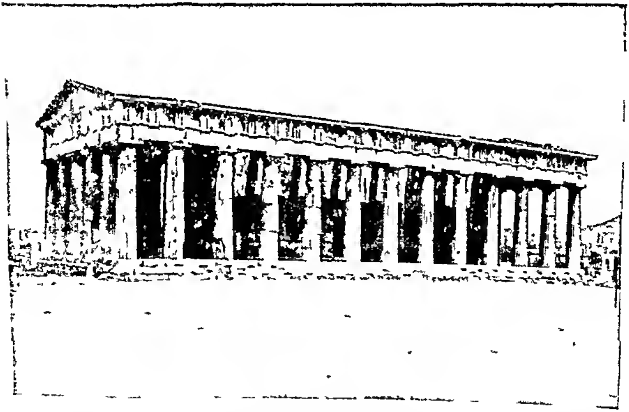

THE TEMPLE OF THESEUS [*Alinari*

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condition of the peasants, Jeremiah and the second Isaiah far away in Palestine are thundering against national vices and apostasy and striving after a higher spiritual education of Israel

Different Roads

To the same end Greek and Hebrew pursue different roads The later Hebrew prophets had reached the high religious idea of monotheism Yahweh was the sole God Meanwhile in Greece Pisistratus is re enforcing the worship of the Greek gods building pagan temples and instituting *religious festivals He is credited* with appointing a number of literary men to collect and revise the poems of Homer and give them a sort of canonical form a work as important in the *literary history* of Greece as was the issue of the Authorised Version of the Bible in English history

The Greek and the Hebrew religions alike grew and developed making painful steps upwards from a barbaric level The Hebrew started with a tribal war god and ended with pure monotheism the conception of One who was God of the whole world The Greeks began on quite as low a level as the Hebrews and ended with Hellenism to which the world is for ever indebted

In the Greek Olympian age the gods are glorified beings with human passions and super human power Homer s gods are immortal but still very human his human heroes are half divine

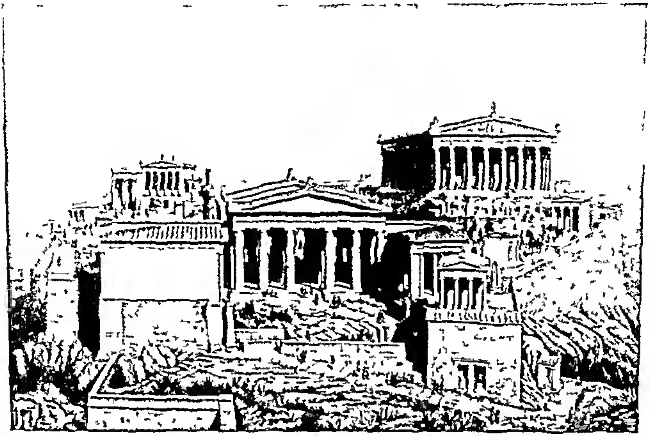
The traditional gods are explained as being so many great men of past ages who have in their various ways saved humanity The Olympian gods and divinities form a certain hierarchy ruled by Zeus but each has a domain or function of his own with certain powers and character We have a picture of advanced polytheism Zeus was the chief of the Olympians the supreme god Apollo his son possessed of many and various powers and Athena also possessed of many attributes These are the three supreme Olympians Athena was the especial patroness of the Athenian state We need not speak of many other Olympian gods and goddesses for we assume that most readers know at least something of Greek mythology

We shall follow here Professor Gilbert Murray s *Four Stages of Greek Religion* As this very informing book is we believe out of print we are taking the liberty of quoting freely

[Anderson

THE DELPHIC SIBYL
By Michael Angelo

In the Sistine Chapel of the Vatican Delphi was the seat of prophecy from the earliest days of Greek tradition The questions were given in writing and the responses were uttered by the Pythian priestess



[Mansell

RECONSTRUCTION OF THE ACROPOLIS AT ATHENS

'The Acropolis' was the name given to the citadel in cities of Greece and Asia Minor It was generally built upon a rock or hill and commanded the city and surrounding territory The most famous Acropolis is that of Athens which owing to its historical associations and the famous buildings erected upon it is known as "The Acropolis" In this illustration can be seen the Parthenon Erechtheum Propylæa and the beautiful little Temple of the Winged Victory

Professor Murray says "In the memory of Greece the kings and gods of the Heroic Age were transfigured What had been really an age of reckless brutality became in memory an age of chivalry and splendid adventure The traits that were at all tolerable were idealised, those that were intolerable were either expurgated, or, if that was impossible, were mysticised and explained away And the savage old Olympians became to Athens and the mainland of Greece from the sixth century onward emblems of high humanity and religious reform It is true that the Olympian religion is only to the full intelligible and admirable if we realise it as a superb and baffled endeavour, not a *telos* or completion but a movement and effort of life" If Olympianism was not a faith, says Professor Murray, it was at least a vital force in shaping the cities and societies of ancient Greece And, "it reduced the horrors of the '*Urdummheit*' (which means 'Primal stupidity'), for the most part, to a romantic memory, and made religion no longer a mortal danger to humanity" The Olympian religion failed "in the attempt to bring intellectual order into the welter of primitive gods The only satisfactory end of that effort would have been monotheism It is curious how near to monotheism, and to monotheism of a very profound and impersonal type, the real religion of Greece came in the sixth and fifth centuries B C Certainly Greek monotheism, had it really carried the day, would have been a far more philosophic thing than the tribal and personal monotheism of the Hebrews But unfortunately too many hard caked superstitions, too many tender and sensitive associations, were linked with particular figures in the pantheon or particular rites which had brought the worshippers peace If there had been some Hebrew prophets about, and a tyrant or two, progressive

and bloody-minded, to agree with them, polytheism might perhaps actually have been stamped out in Greece at the time. But Greek thought, always sincere and daring, was seldom brutal, seldom ruthless or cruel. The thinkers of the great period felt their way gently to the Holy of Holies, and did not try to compel others to take the same way. Greek theology, whether popular or philosophical, seldom denied any god, seldom forbade any worship. What it tried to do was to identify every new god with some aspect of one of the old ones, and the result was naturally confusion."

The National Gods

Greek mythology was not governed by dogmatic statement or under any sacerdotal control. An individual citizen was not obliged to believe any particular myth, but if he showed disbelief in the existence of the gods and refused to take any part in the ritual of the community he might be called to account as a "suspect" Ritual was more important than doctrine The people regarded their national gods, and reverenced them, much as the ancient Hebrews were taught to regard their tribal Yahweh But with the Greeks, of course, there was no priestly order to compare with the Hebrews. For the Athenian, to deny the national gods was sacrilege; it was also disloyalty to the State. It was such disloyalty, such sacrilegious impiety that was charged against the notorious Alcibiades

The Greeks, like the Hebrews, were much addicted to consulting oracles or soothsayers To consult an oracle was equivalent to consulting the old men of the tribe. *They* knew what was "holy and unholy, correct and forbidden"; they could tell what *they* did and what their ancestors did "When the oldest man in the tribe could not tell you the right thing to do, you went to the blessed dead All oracles were at the tombs of heroes They told you what was 'Themis,' what was the right thing to do, or, as religious people would put it now, what was the will of God" Sometimes the oracle foretold events.

An Oracle is the response delivered to a worshipper or inquirer, or the place where the supernatural being delivers the response. The consulting of an oracle was as common among the early Hebrews as it was with the Egyptians and the Greeks. The Hebrew oracles were either by word of mouth, as in the speech of Yahweh to Moses, or in dreams and visions. The ancient belief was that the presence of the spirit at the oracle, or in taking possession of a person imparted supernatural knowledge. The belief in temporary incarnation or inspiration was worldwide.

We mention this analogy, but between the Hebrews and the Greeks who received these revelations there is also an essential difference. The Greeks went on pilgrimage to Delphi and put their questions. The Hebrews who received revelations were passive, waiting for an event conceived as a spontaneous act of Yahweh.

In ancient Greece oracles were numerous; Delphi was particularly famous for its oracle; the shrine of Apollo at Delphi became a national religious centre to which the greater part of the Greek world resorted. It was the greatest shrine of Hellas.

The word oracular in our language is used as signifying something obscure or ambiguous, as well as meaning something authoritative. There are many famous classic examples of ambiguity in utterances of the Delphic oracles For example, Crœsus consulted the Delphic oracle respecting a projected war. He was told that when he passed over a certain river he will overthrow the strength of an empire He supposed he would overthrow the enemies' empire. Alas! it was his own empire that he destroyed Philip of Macedon when he sent to ask if his Persian expedition would prove successful received the answer:

> The ready victim crowned for death
> Before the altar stands

Philip took it for granted that the "ready victim" was the King of Persia, but it was Philip himself.

§ 4

Socrates and the Athenian Gods

WHEN we come to the age of Socrates and Plato we see what the Olympic religion stood for in the higher minds of the Greece of the

fifth and fourth centuries B.C. If your mind runs that way you may see an analogy in Socrates and Plato as the Jeremiah and Isaiah of ancient Greece. They lifted religion to a higher plane—at least they tried to. The political state of Greece at this time was a very disturbed one.

The Greek states are engaged in continual warfare. The Athenian Empire under Pericles, a wise governor and capable general, was at its best about the year 450 B.C. Politically this was her golden age—to be followed by decline and fall. The conflict known to history as the Peloponnesian War broke out in 431 B.C. It lasted with intermission for nearly thirty years. During the following fifty years there were numerous other wars until finally Greece was conquered by Alexander the Great. Alexander the Great died at the age of thirty-three in 323 B.C. He had subjugated the Greek states and become head of a Greek league. His great empire was divided among his generals.

During all these years of almost continuous political troubles of the Greek states the greatest philosophers of Greece lived and died—Socrates, Plato and Aristotle supreme among them—the last named died a year after Alexander the Great.

THE SIEGE OF TROY [Mansell

From a drawing by Paul Chenavard in the Museum, Lyons. Among the heroes were Achilles, Hector, Ajax, Ulysses, Agamemnon. In Homer the Gods themselves took sides in the great drama.

From the time of Homer to Socrates's day four centuries had elapsed.

A Golden Age

The age which saw the gradual decline and fall of Greece was the golden age of Greek philosophy. And that is what we are concerned with here—Greek religion and philosophy. The beginning and development of philosophy during the period we have reached is the prime fact in the history of the Greeks, along with Greek art and literature.

About the middle of the fifth century B.C. (the time of Socrates) an intellectual revolution among the educated classes (not always of social rank—Socrates was a poverty-stricken man) had set in; a spirit of free inquiry and scientific thought was abroad; traditional faith was going; belief in the old Athenian gods had almost expired—but not quite, otherwise Socrates would not have been put to death. Thinking men were discarding older notions and beliefs, whatever the big public still believed. Science as we know science was hardly born. The apparatus for experiment and observation had not been invented. Astronomy and mathematics were two

favourite fields of study, some set themselves to investigate the nature and origin of the world, and as to this they were mainly interested in conjecturing an ultimate "substance" out of which all material things originated Thales declared it to be water, another air, another fire, and so on

In the history of the Hebrews we saw the rise of a succession of great prophets who left an imperishable mark on later ages In Greece, at the period we have reached, a spirit of free inquiry and scientific thought was abroad We see an outburst of unique intellectual force, and an artistic outbreak which has never been paralleled

The Hebrew religion and the vision of God sprang from the prophets, the Greeks, without help from their pre-existent religion, set out to try and understand by the ways of inquiry and reason the nature of the world and the right way to live Thales (died 540 B C) was followed by Pythagoras, Socrates, Plato, and Aristotle The great contemporary figures in art and literature we shall not speak about

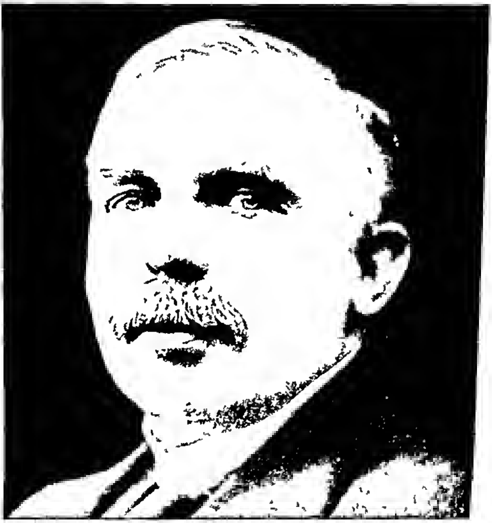
Socrates

In subsequent chapters we shall deal in more detail with the life and philosophy of Socrates, Plato, and Aristotle We refer to them here merely as the link between the religion of Greece and the new Christian theology that was to come, and to which this summary leads up The Hellenistic period reaching roughly from Plato to St Paul, is Professor Murray's third stage of Greek religion For Socrates and Plato philosophy was a "way of life" We may call it philosophy or we may call it religion Socrates has been called the first notable non-conformist in history If he believed in the gods it was far from being a literal or traditional belief, they were symbols of something beyond them He was suspected by the common people of having a private religion which might be a dangerous influence against the Athenian democracy He tried to waken among the Athenian youth "a desire to know" He demonstrated relentlessly the vagueness and hollowness of men's notions and beliefs about most things, about matters they never closely examined, defined, or vigorously thought out His Socratic method of definition exposed fallacies, delusions, inconsistencies, and his bewildered listeners learned that there were alternatives to many beliefs sincerely or vaguely held Nothing is to be taken for granted

Socrates accused of Impiety

In the end, at a time of political complications, Socrates was accused of impiety in introducing religious novelties and of "corrupting" the youth of Athens He was condemned to death, and did die by drinking the poisonous hemlock "I was not unconscious," he told the court of 501 Judges, "of the enmity which I proved, and I lamented and feared this, but necessity was laid upon me—the word of God, I thought ought to be considered first" The account of his death is given in Plato's *Phaedo*, one of the precious things in literature Plato says that Socrates was the wisest and justest and best man that he had ever known The main subject of the *Phaedo* is the immortality of the soul, but we shall leave for a later chapter a more detailed account of the philosophy of Socrates and Plato We shall see how mythology gives place to allegory and with the educated classes the Gods are regarded merely as images, symbols, or merely metaphors

(*To be continued on page 243*)



LORD RUTHERFORD

He is one of our most eminent physicists and the modern theory of the structure of the atom is largely due to his brilliant researches and experiments. He was born in New Zealand and is now sixty-three years of age. He succeeded the late Sir J. J. Thomson as Cavendish Professor of Physics at the University of Cambridge.

BOOK I—(*Continued from page 152*)

SCIENCE AND MODERN THOUGHT

CHAPTER V

MODERN BELIEF ABOUT THE PROBLEM OF MIND

§ 1

WE may now go back to the subject of Evolution In the light of present knowledge, what has Evolution got to say about the mind of man? In the main the whole spirit of modern thought is to look on the world, and life, in terms of *continuity* that is to say, evolution is all embracing, and if this principle of continuity is to be accepted it has to be applied to the mental side of man as well as to the physical side of his evolution Mind is no longer regarded as a distinctive human attribute It must be understood, however, that the term is used in a wide sense to include the whole of the inner or subjective life—feeling and purpose, as well as intelligence.

Is the brain the mind?

To begin with let us see what the views are of some authorities about the brain and its functions Has what we call " mind " a material or physical basis and that physical basis the brain? For an answer to this important question let us give a short resumé of the views of an authority like Sir Arthur Keith And first about the brain, and particularly in relation to its highest functions

The brain is ' the master contrivance of the human machine, the most intricate machine of which we have any knowledge ' It is the great cortical fields of the cerebrum which ' represent the highest flights of nature's inventive genius '

" It is by the invention of an elaborately contrived cortical mechanism that Nature has given the human brain the power to see, hear, think, and act, countless myriads of microscopic operatives carry out the functions of both remembrancer and judge They constitute the sphere of pure intellectual activities " From that it would seem there is no distinction between the brain and the mind of man, but let us proceed

We take, by the kind permission of *John o' London's Weekly*, the following passage from an informative article by Sir Arthur Keith on this aspect of the brain ' What is it that makes us speak of one animal as being ' higher ' than another? By ' higher ' we mean more ' man like '—in behaviour and ability Now the particular gift which has been given to man is that of making a deliberate choice, he can turn a matter over in his mind and after looking at it from all sides determine his course of action

" What is it that has given man this power of choice? On this all medical men are agreed, it is the enormous development of the cortical areas of his brain This ' power of choice ' appeared late in the history of living things The intelligence of bees, ants, and of all lower forms of vertebrate animals is of a ' press the button' kind under a given set of circumstances the animal can act in only one way Every predicament calls forth its one particular reaction With the evolution of mammals cortical areas began to be added to the surface of the brain

ARE THEY ALL "THINKING" OR

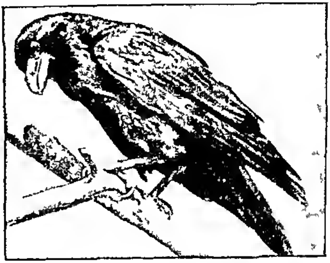
THE THINKER
By Auguste Rodin

ARE THERE DIFFERENT WAYS OF "KNOWING"?

(See page 207)

This Orang-utan appears to be meditating deeply. "Watch a monkey," says Professor Thorndyke, "and you cannot enumerate the things he does, cannot discover the stimuli to which he reacts."

[Photo: James's Press Agency

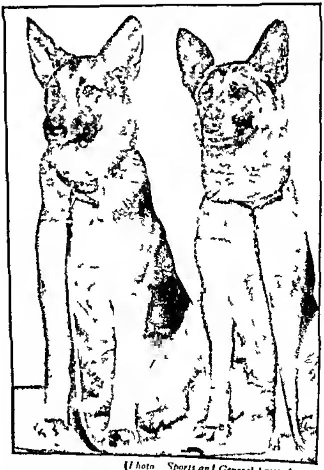


[Photo: F. W. Bond

The knowing air of the raven is borne out by its reputation as one of the brainiest of birds; it orders its life with real sagacity, is educable and an accomplished mimic.

[Photo: Frances Pitt

Master Fox frequently has to make up his mind about matters of life or death. His ability to profit by experience is undoubted.



[Photo: Sport and General Press Agency

The acute senses and intelligence of Alsatian wolf dogs are remarkable. They possess strong powers of establishing mental associations.

In man this 'grey matter' of the brain has reached colossal proportions

"Let me give the reader a slight indication of how complex is the organisation of the cortex of the human brain It is made up of living units, known as nerve cells These cells vary in size, but when I say that if a series is arranged in a row, 3,000 of them will be needed to extend along a line an inch long To cover a square inch one cell deep, 9 millions of them would be needed

"Now, lately a very complete census has been made of the number of nerve units contained in the cortex of a human brain of moderate size When we think in numbers we are impressed by the seven millions of human lives centred in and around London, London, as regards numbers, would make but a tiny area of cortex, even if we take the population of the entire earth—now reckoned at 1,900 millions, we shall have living representatives of the nerve units of only a single convolution The number of distinct units in the cortex—the seat of delibera tion—of an average human brain is 14,000,000,000 Not one of these cells is isolated, all are joined and connected by fine nerve fibres or fibrils—so that we have something of the nature of a living web

"Each unit is alive, it needs food and air, cut off oxygen for ten minutes and a nerve cell perishes beyond recovery Soak these nerve units in intoxicants and their action becomes unreliable, ply them with anæsthetics and they cease to act

"We human embryologists have opportunities of noting every stage in the assembly of this colossal army of nerve units which form the cortex of the brain By the time the embryo is three weeks under way the cells begin to gather in the brain and to arrange themselves, the total number is assembled long before a child goes to school, but the connections are not fully established until about the twentieth year

"And lastly comes that fateful question, has what we call mind, a material or physical basis and that physical basis the brain?

"My good friend Sir Oliver Lodge, who knows much more about the ultimate constitution of matter than I do, holds that the *mind* is an *immaterial* something which comes out of the depths of space and makes a home in a human brain for a season—until death gives it release for another term of space If this is so, why then such an assemblage as is represented by 14,000 millions of living units, with their complex interconnections? Why the consumption of material things—such as food and oxygen? Why should damage and disease cause insanity? Why should material drugs produce characteristic actions on the brain? If we accept the brain as the material basis of mind we can explain these results

"With the evidence which I have thus briefly outlined in their possession, is it possible for medical men to come to any other conclusion than that 'mind' has a physical basis and that 'mind' is a manifestation of the action which goes on in the multi millioned living units of the brain? Think for a moment of the object which medical men have in view—it is to understand the brain so that they may know how to prevent mental illness—or, if unpreventable, how to relieve mental distress and lead the brain back to health Devils do not enter the brain from without, they are bred within, they are born in the matter of the brain

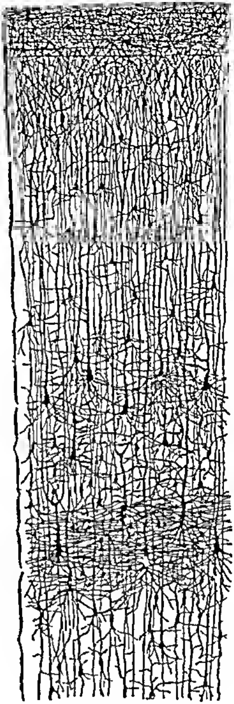
"A 'smile' appears to most of us to be, like 'mind,' a separable entity Readers will remember the Cheshire cat, it departed all but its smile—which Tenniel tried to depict with his pen He found it necessary to introduce the lineaments of a cat—to provide a physical basis for a smile 'Mind' stands in the same rela tionship to the brain as a smile does to the facial musculature Paralyse the face and the smile vanishes, withdraw oxygen from the brain and there is an end of mind

"We do not know the ultimate nature of 'life', much less do we understand how matter first assumed a living state But we have no know-ledge of life apart from matter, and in the very simplest form of living matter there is present a sentient power—the beginning of consciousness and of mind In man's brain we see the climax of this primitive sentient power—which is as old as protoplasm"

Neo Materialism

Such then are the views of Sir Arthur Keith, and from all this we are to believe that "mind" has a physical basis, and that basis the brain, the brain is the seat of consciousness, of thought, the seat of "deliberation," of "choice", the action which goes on in the multi millioned living units of the brain manifests mind. Is this pure materialism? Or, is it but a materialistic description of the mental activities of a living being? The multi millioned units of the brain are *living* cells, but the ultimate nature of "life" is not known, nor does science understand how matter first assumed a living state, nor the origin of "consciousness", nor, therefore, the ultimate nature of mind. We may call this doctrine neo materialism. We only know how mind is manifested in the physical world of living matter, the ultimate constitution of matter itself is not known either, no doubt the science of physics has a great deal yet to learn about the properties of the entities that compose "matter".

We do not wish it to be understood that all the views given above are the accepted conclusions of all authorities, in every particular they are not. The generally accepted view, we think, is that the brain is not the mind, but the organ bringing mind into effective activity.



THE CORTEX

(Highly magnified)

From 'Quain's Anatomy' (*Longmans, Green & Co*)

The fore-brain or cerebral cortex is the seat of human deliberation. It comprises a complex net work of living cells, connected by inter lacing nerve fibres. The number of distinct units in the cortex of an average human brain Sir Arthur Keith says is 14 000 000 000. Not one of these cells is isolated, all are joined and connected by fine nerve fibres—so that we have something of the nature of a living web. (See page 200)

§ 2

Conflicting Theories

WE have said elsewhere that the mathematical physicists, who have done so much to revolutionise our views of the nature of the physical universe, can never tell us the true intrinsic nature of things. They can tell us a great deal about the structure of the atom, its inner constitution, and the behaviour of its electrons, but the ultimate nature of the electron is hidden from them, just as the nature of Life is hidden from the biologist. It is *possible* that the nature of Life lies outside the realm of the knowable. Meanwhile, as has been fitly said, if we cannot understand what *Life* is, we shall come

living things differ from non living things in degree and not in kind, the same laws are at work, but in a far more complicated medium in living things. Of course, the present state of knowledge furnishes us with no *link* between the living and the non living, but the gap is much less than it was a hundred years ago when the synthetic chemist began his series of remarkable achievements in artificially building up organic compounds from very simple materials.

Mind then on the view we have been expressing is somehow associated with Matter. Mind emerged, it is supposed, it did not come in from outside. Some degree of consciousness cannot be denied to the lowliest creatures down to the amœba, about the lowliest of all. This view is lucidly expressed by Wells and Huxley in their *Science of Life* to which work we refer the interested reader for a very thorough exposition.

[Photo Elliott & Fry

BERTRAND RUSSELL

He is the author of *An Outline of Philosophy* and one of the foremost mathematical philosophers of the present age. "The crude materialism of a previous generation," he says, "receives no support from modern physical science if, as seems to be the case, physics does not assume the existence of matter."

They suppose that "Something of the same general nature as consciousness accompanies the activities of all living matter, it may be of all matter, but it is generally beyond comparison feebler than ours and, like the electric properties of ordinary nerve or muscle, is undetectable by ordinary inspection and is of no specific use to the animal."

This view is perhaps well founded but the exposition of these two authors' views should be read in their entirety in the valuable work mentioned. The subject is a contentious one and a scientific solution of the problem is not yet possible. The authors of *Science and Life* hold the view that the brain is the organ bringing mind into effective activity.

"To regard a conscious being in this fashion is quite incompatible with the older idea of him as a 'soul' imprisoned in a 'body.' He is, on the contrary, a portion of the stuff of reality organised so that it is intensely conscious, he is not mind *and* body, but body and mind in one. Body is one aspect of this unity, mind is another. The matter of physics and chemistry, and the conscious spirit of the human mind, are two aspects of the organisms we call men and women. In the light of such a conception the old question whether mind determines the actions of matter or matter determines those of mind, ceases to have any meaning at all. If our thoughts and our brains and bodies are only two aspects of one reality, we cannot think of our living brains and bodies apart from our minds. If the world stuff is organised in a particular way, in the form which develops into a human being, it will be both a body and a mind. Man, on this hypothesis, is not Mind plus Body, he is a Mind Body."

Mind body

The term "Mind Body" simply means that we must think of a unity which has both a psychological and physiological aspect, at times one or other is predominant or accentuated, but they are inseparable. For instance, "at some

were not there in co-ordinated interaction from the first germ of life onward, how and when can they ever get together and work together?"

The theory we have been describing is not the same as the theory of 'emergent' evolution held by Professor Lloyd Morgan. The difference is in the meaning of the term 'emergent," or in what way we are to imagine this emergence came about. Professor Lloyd Morgan says, "Our aim is to treat all mental events, including all modes of human perception and thought, and all modes of human emotion, in exactly the same manner as though we were concerned with any other instances of advance within the plan of emergent evolution. In brief, mind no less than life, and life no less than atomicity or molecularity, fall within the emergent schema." Lloyd Morgan, however, stresses "emergence," that is to say, the appearance of *new* properties or faculties in the organism at particular stages of evolution, which were not present in latent form at a stage prior to their emergence. They are qualitatively new. Each higher stage is *super*natural to that which precedes it, being "a new and emergently higher character or quality of the natural—a further manifestation of the substantial unity of Divine Purpose." It comprises mental no less than physical events. *Mind* is an attribute of Nature and is emergent.

Lloyd Morgan postulates a "Divine Agency." He says, "Many of those who attribute, as I do, the whole sweep of evolutionary advance to Spiritual Agency, conceive the Divine Purpose, thus manifested, as itself timeless and omnipresent and, therefore, not susceptible of treatment in temporal or spatial terms." But this is philosophy.

§ 4

THE problem of Mind is one of the most interesting as it is one of the most baffling. All that can be known about the nature of mind is dependent on inference. As in so many other branches of science after analysis has been carried to its utmost limits there is something left over, unamenable to analysis or explanation. Every department of science has its mysteries, its unsolvable problems. The visibles and measureables are constantly changing to the invisibles and non-measurables, the scrutable to the inscrutable. The nature of mind is one such problem. No one has succeeded in making clear the relation between mind and body. Mind influences the body, and the body the mind; their interaction is beyond dispute, but the relation of the two is an unsolved riddle.

We shall not do more than give this bird's-eye view of this subject now; to do more would take us into too much detail regarding conflicting theories. We shall indicate what these are in another section of this work (Book II). Dr Broad in his well-known work *The Mind and Its Place in Nature* says, that it appears to him that *seventeen* different types of metaphysical theory are possible theoretically on the relation between Mind and Matter. We shall refer to the main theories under the subject of Psychology.

Meanwhile to the question, Is consciousness merely an aspect of reality or a separate independently active factor in living realities? we have indicated what seems to be the answer of eminent biologists and psychologists. But the question is one that is not easy to answer, and the finding we have outlined is not a unanimous one.

We shall have to speak later on about Personality. Is Individuality a mere difference from others, each playing an individual part within the unknowable unity of one universal Personality, of which, because unknowable, our own individual minds can form no conception? This limitation of our faculties leads us to some sympathy with this declaration: "Those who think that a *disbelief* in immortality is justified by science and philosophy are the dupes of their own cleverness or erudition." But we shall have to consider later on what meaning is to be attached to this word "immortality." Meanwhile let us see what life is like in its lowest forms.

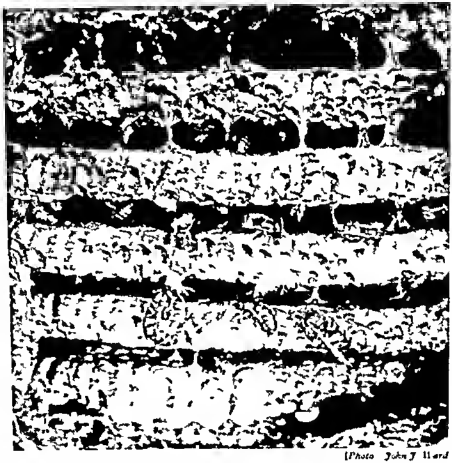
CHAPTER VI

THE PROBLEM OF INSTINCT

IF we frequently use the word mystery in the course of discussing the deeper problems that science investigates it is because science so often comes up against problems to which no solutions are found In the present state of knowledge they are mysteries One such problem is the nature of Instinct It has not been solved When all has been said about instinct that can be said, in the long run it becomes a philosophical question, in the same way that the origin and nature of Life is The rôle of philosophy begins where that of science ends, and then we are at liberty to indulge our own particular and individual beliefs, provided, of course, we avoid all self contradiction

We shall leave until later a discussion of the present-day trend of thought about some problems that belong more to philosophy than to science Here, and preliminary to hat, it will be profitable o consider the interesting questions of (1) instinctive behaviour of animals, (2) intelligent behaviour, and (3) some further questions that arise out of these points Our consideration of animal instinctive and intelligent behaviour will help us to a better understanding of Psychology and Mind It is the business of psychology to study the activities of mind so far as they can be known and described Mind is associated with life and, as we have already said, if we take the evolutionist view we cannot suppose that "mind," suddenly appeared in organisms which were previously without mind, that is to say, on logical grounds the evolutionist does not suppose that mind was suddenly interjected into organisms from without As a matter of fact, however, we are all familiar with the gradual appearance of mind in the development of a child

It is not the province of psychology (since it has not the means of knowing) to explain what



[Photo John J Ward

A MARVEL OF INSTINCTIVE HOME BUILDING

Bees and wasps are purely instinctive creatures The nature of instinct has not been solved

The interior of a wasps nest The dome shaped cells on the bottom comb are those occupied by the queens Immediately above, two young queens can be seen emerging from their cells while a male wasp rests on the comb between them The wasps seen above are workers busily engaged in tending the young wasps or in making new comb

time the man is in his armchair reflecting on the universe, which is, of course, a mental adventure But it is not altogether activity of Mind, since the flow of the philosopher's thought is influenced by his digestion Even when he is philosophising in his armchair he is not mind only, but Mind body "

The degree or the nature of consciousness varies according to the complexity of the organism, on the principle of continuity we must assume that there is probably no break in the fact of consciousness, or something analogous to mind, all along the line of evolution from the lowliest organism to man himself

These views indicate the trend of present day beliefs We have seen how the " new physics " has changed the old views about the constitution of matter, and we need not repeat What physicists now study in their research into the nature of matter are electrons, and electro magnetic waves, or radiations That is what matter is, in so far as physicists have been able to discover

The crude materialism of a previous generation, as Bertrand Russell says, " receives no support from modern physical science if, as seems to be the case, physics does not assume the existence of matter " To our senses, of course matter exists as substances we can see and feel and handle physiologically our nervous system and brain are material No one doubts that consciousness has a material substratum, that is to say, it accompanies bodily life, on the other hand, no one can explain the relation between the mental state and the physiology of the nervous system No one can profess to know what matter is in itself, but as Santayana says, " that matter cannot by transposition of its particles *become* what we call consciousness is an admitted truth, that mind cannot *become* its own occasions or determine its own march, though it be a truth not recognised by all philosophers, is in itself no less obvious

§ 3

IT is the fashion among contemporary thinkers to assume the existence of an essence more primitive than mind and matter, that is to say, mind and matter seem to be a sort of composite of an unknown primordial existent called " neutral stuff," supposed to be " the actual stuff of reality." Thus Russell and others suggest that the stuff of which mind and matter are compounded " *lies* in a sense between the two, in a sense above them both, like a common ancestor "

This " common ancestor " called ' World stuff " is merely a hypothesis, in other words, it is a term invented to express a hypothesis, a hypothesis called in to explain the origin of all that we are from some unknown reality

But, to return to Mind Out and out materialistic or mechanistic doctrine declares that the brain *is* the mind, and the mind is the brain No proof of any kind has ever been put forward that mind is a by product of matter, that is to say, ' matter " as we know it as a physical substance No one has ever shown what the chemical or mechanical changes are by which thought and willing are produced Admittedly, there is co relation, an interaction between mind and body But that is the farthest that present day science can go A generally accepted view would seem to be something like what Dr Bernhard Bavink expresses in the following words " It is probable that neither is the mind a mere function of the brain nor the brain a mere tool of the mind but that both are functions of an unknown ' third,' and are therefore connected with one another in some way—how, we do not know

The trend of modern thought is towards the belief that mind is essentially free or creative a *vera causa*, that consciousness is not a mere function of the brain, rather, that consciousness uses the brain as an instrument What we have to take into account is the living organism as a complete whole, and the key to the whole has not been found, vital reactions are not to be explained by physical mechanistic activities alone

Mind is characteristically creative, in illustration let us quote from Dr Bavink's *The Anatomy of Modern Science* " It is absolutely certain that in the whole of Nature a watch or an electricity station would never have come into being without man and his mind These are something entirely new, to which nothing

analogous exists anywhere, even in living Nature They give us a picture, and without doubt the best picture, of the creative process which is behind all creation in Nature

"This process, which takes place in Nature unconsciously, is continued consciously in man, to which statement we must add, in order to avoid misunderstanding, that in Nature, apart from man, it is unconscious only from the standpoint of the single created individual Whether or not it is consciously known to a highest consciousness is an entirely different question"

We see then, as Thomson and Geddes put it, that, "mentality cannot be juggled out of mechanism" In a word, "a machine cannot have a theory that it is a machine", neither mechanistic methods nor facile vitalistic ones lead to adequate descriptions of living In the realm of organisms there are three distinct orders of fact, they are "matter," "life," and "mind," each with its characteristics—"distinct, though their continuity is becoming increasingly clear" They overflow and interpenetrate, and "it is a waste of time and wits to continue to pit against one another the mechanistic and the vitalistic description of living creatures" Matter, life, and mind—they cannot be separated, say this school of thinkers In the variety of Life in Evolution there is underlying unity, "at so many levels, from microbe to man, and from simplest organic life processes to their highest outcomes and even ideals"

[Photo Elliott & Fry

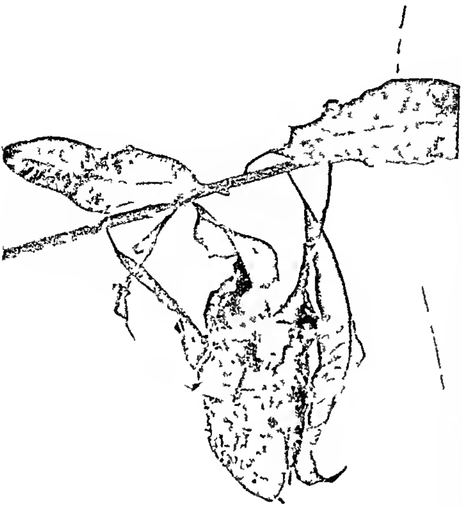
DR C D BROAD

The author of *The Mind and its Place in Nature* In his view if human survival can be rendered probable at all this can be done only by empirical arguments based on the phenomena which are treated by Psychical Research His own theory will be explained in a later chapter

Vitalism

Those who argue for positive vitalism, that is, a genuine vital agency, not only subordinate the part played by mechanism in the life-process, they *reject* it, maintaining it is a wrong way of approaching the problem The dispassionate comment of the two authors whose views we are quoting is to point out the varied pattern of living organisms they say, "A radical objection to this view is the apparent continuity of evolution For it looks as if living organisms had emerged (at present one of the 'blessed words') from non living materials, it looks as if undeniable 'minds' or mental aspects had arisen as new syntheses in animals the ancestors of which were not more than latently mental, just as the clever child arises in individual development from an egg cell, the 'mind' of which is hard to seek" This is not mechanism and it is not the older vitalism, it is an intermingling of the two

These two authors are among many authorities who insist that the concepts of chemistry and physics do not suffice to cover the whole field of life, life cannot be adequately described in terms of mechanism "The living is an historic being enregistering its experience, it is a purposive individuality that gets things done, it grows, multiplies, develops, struggles, varies, and evolves, it often has a mind of its own" "In all manner of ways we are pressed to the view that biosis (protoplasmic life) and psychosis (mental life) are everywhere associated throughout living nature If they



[Smithsonian Report 1925

A REMARKABLE ACHIEVEMENT

The Indian Tailor bird performs the most intricate operations in the construction of its nest. The Tailor bird is a small wren like bird with a sharp bill. The nest is built of leaves and filled with a cotton like material. The hen punctures holes in the leaves and then lightly "sews" or laces them together using the cotton like material or fibre as thread. The lining of the nest is then "riveted" to the outside leaves, the whole forming a compact and durable nest, which, hanging between other leaves, is completely hidden from view. For a completed nest see illustration on the opposite page.

mind is—that belongs to the region of philosophical speculation. Psychology is the science of the behaviour of living things, and for the present we shall confine ourselves to that.

It will serve our purpose best if we first trace shortly the progressive evolutionary advances leading up to "intelligent" behaviour in animals. *In the story of evolution there is no* chapter more interesting than the emergence of mind in the animal kingdom. But it is full of difficulties, partly because "mind" cannot be seen or measured; it can be only *inferred* from the outward behaviour of the creature; and partly because it is almost impossible to avoid reading ourselves into the much simpler animals.

The philosophy of instinct takes into account all that is definitely known on the biological and physiological side and draws its conclusions from that and from what is *not* known by scientific investigators. We can see with our own eyes the manifest and manifold capacities of bees and ants and birds and other creatures for doing the most extraordinary things, which are done without conscious intelligence or any reasoning faculty. We think of the achievements and industry of ants and bees, the spider's web making, the bird's nest building and so on, nothing of which requires, initially at least, to be "learned" by the individual bee, ant or bird. There is no *complete* explanation of their amazing achievements. They *know* how to do the most intricate and wonderful things, and yet it is perfectly clear that they can have no fore knowledge of the end in view—as for example, in the case of the solitary wasps who stock a nest with food for the unborn young they will never see, placing caterpillars which

they have first stung and paralysed in the nest where they have laid their eggs Then the parent wasp departs, never to return, but the larder for the unborn orphan wasp is there waiting its emergence from the egg This is not foreknowledge on the part of the wasp, but what we call instinct

Inherited Capacity

In studying the behaviour of animals which is the only way of getting at their mind for it is only of our own mind that we have direct knowledge it is essential to give prominence to the fact that there has been throughout the evolution of living creatures a strong tendency to enregister or engrain capacities for doing things effectively Thus certain abilities come to be inborn they are parts of the inheritance which will express themselves whenever the appropriate trigger is pulled The newly born child does not require to learn its breathing movements as it afterwards requires to learn its walking movements The ability to go through the breathing movements is inborn engrained enregistered

In other words there are hereditary pre-arrangements of nerve cells and muscle cells which come into activity almost as easily as the beating of the heart In a minute or two the new born pigling creeps close to its mother and sucks milk It has not to learn how to do this any more than we have to learn to cough or sneeze Thus animals have many useful ready made, or almost ready made capacities for doing apparently clever things In simple instances of these inborn pre arrangements we speak of reflex actions in more complicated cases of instinctive behaviour And very remarkable behaviour it often is and its origin difficult to understand

[Smithsonian Report 1915

TAILOR BIRD'S NEST MADE FROM A SINGLE LEAF

Sometimes the nest is made from a single leaf The method of sewing is as follows The bird pushes one end of a cotton thread through a puncture on the opposite edge of the leaf The cotton used is soft and frays easily so that the part of it forced through the tiny aperture issues as a fluffy knob which looks like a knot and acts as such for the silicon of the leaf prevents the threads from slipping If the threads used are long enough the bird passes them through and through the holes until the whole length is utilised

§ 1

IF science has nothing to tell us of the origin or nature of life, it is almost as perplexed on the subject of instinct We know that instinct is associated with life, and that is all we know on the positive side We shall depart from our usual brief summary in giving here a more detailed account of the subject we are dealing with leading up to the various theories about instinct Instinct is one of the fundamental questions that all investigators have to tackle

The term Instinct

But a word is needed about the use of the term instinct In our common speech it is used in a variety of ways

A person may say that he has an instinctive belief that so and so is true; or that he did such and such a thing instinctively, meaning without reasoning or by unconscious impulse, or according to a fixed habitual predisposition, like instinctive pugnacity, and sometimes it is used in the sense of intuition Naturalists use the term to mean an inborn hereditary capacity for doing things, and often apparently clever things, in a routine which does not require to be learned, such as when a spider makes its web or the bees build a honeycomb, it is not the result of acquired habit, but is independent of individual experience An animal may do a very remarkable thing without its ever having tried to do it before, or even having seen it done

Away back at the very beginning of things in the ascending scale of evolutionary life the first creatures must have been dependent on "instinct," if we may use that term prematurely, for their existence To use the word instinct in that sense is only another way of saying that these first creatures, in movement, feeling and multiplying were fulfilling the law of their being Wherever there is the activity we call life there is in the organism the power to sustain its life and maintain itself as a going concern That power is implicit in the primordial organisms and in the individual germ-cell

In the lowest organisms the term used for their natural reaction to their environment is "reflex action" A reflex action and a considerable part of the behaviour of the lower animals is reflex, is a movement which takes place without reference to any will, it is purely automatic A reflex movement is the result of stimulation and of predetermination and prearrangements of nerve cells and muscle cells which secure that a fit and proper answer is given to a frequently recurrent stimulus

Back to Protoplasm

But let us go back a little farther to biological beginnings In the search for origins—reflex movements, instinct, intelligence, and reason if you like—we have to go back to the beginnings of terrestrial life, in a word, we have to go back to protoplasm which Huxley described as "the physical basis of life" If we believe in the unbroken continuity of evolution, and that there never was any such thing as a special creation of different species then it was out of the primitive properties of protoplasm (and we shall see by and by what these are) that all our complex sense organs have been built up Protoplasm is the living part of all organisms, whether animals or plants as distinguished from such non living bodily substances which are products of its activity Under the microscope it is seen to be a semi liquid substance, somewhat granular, almost colourless, apparently simple, but really of the utmost chemical complexity Some of the lowest forms of life, like the Amœba, are naked and undifferentiated bits of this living matter It has the power of assimilation, it is sensitive to stimuli—mechanical shock will cause it to contract, strong light or heat will damage it, certain chemicals will attract or repel it, electric currents will force it to move in a particular direction It is out of these primitive properties that all our complex sense-organs have been built up

Referring to the attributes of living matter Sir Arthur Shipley writes "What is it that this protoplasm does that non living matter, such as rocks and stones, never does? To begin with it is *motile* We have seen that it can alter from time to time its outline or shape and by doing this in a certain way it can move forward or

[Pho o F an P t

EYES FRONT

The unanimity of movement in these young kingfishers who are listening for the shrill note of their approaching parents returning with food curiously resembles the action of soldiers at drill. Each fledgling behaves in exactly the same way. It is reacting automatically to its environment by a "reflex" movement. When the attention is fixed "eyes front" the birds gently heave up and down with their heads outstretched and a bewildered look in their eyes.

progress or move backward and regress. Therefore it is *motile* and the slow protuberance of a lobe on one side of the body and the equally slow withdrawal of another on the other side is the first beginning of that muscular contraction which may ultimately produce a competitor for the Olympic Games. As far as we can judge even this simple movement is not always the result of an external stimulus but arises from something in the protoplasm itself and certainly such is the case in the more complex instances of higher life. This initiation of action from within is called *automatism* and protoplasm unlike non-living matter is *automatic*. But it also readily reacts to external impressions or stimuli and is as the physiologists call it *irritable*.

These activities and qualities imply a certain expenditure of energy; how is that energy supplied? What is the oil that drives the engine? It is the food already hinted at. Living protoplasm must have food. It takes to itself certain food

[Pho F P t

RIGHT ABOUT

As the parent birds approach nearer and nearer and circle round them the little kingfishers swing round in unison opening their beaks in expectation of being fed

substances of a high complexity and oxidises and reduces these to simpler substances, and during this process, just as when gunpowder explodes, energy and heat are set free It is also capable of building up the dead food into its own flesh (or into protoplasm), making the dead live, and this quality is called *assimilation*. Further, all protoplasm breathes, that is to say, it takes in oxygen and it gives out carbon dioxide It is in effect *respiratory*" *

That, then, is our starting point, it is out of these primitive properties of protoplasm that all our complex senses (and perhaps consciousness) have been built up Because light will alter the protoplasm of an Amœba, it has been possible for life to evolve an eye The Amœba uses up oxygen and gives out carbonic acid gas, it can move, it grows, it reproduces Such are the fundamental properties of all protoplasm, and on these evolution has reared its great edifice and brought into being that almost incredible multiplicity of species (nearly a million are known already) of animals and plants, ranging from a whale to a flea an oak to a toadstool a tapeworm to a bird, a bacterium to a lily, a jelly fish to an ant community a worm to a philosopher

Reflex Actions

Simple creatures act with a certain degree of spontaneity on their environment and they likewise react effectively to surrounding stimuli Animals come to have definite "answers back," sometimes several, sometimes only one as in the case of the Slipper Animalcule, which reverses its cilia when it comes within the sphere of some disturbing influence, retreats, and turning upon itself tentatively sets off again in the same general direction as before, but at an angle to the previous line If it misses the disturbing influence, well and good, if it strikes it again, the tactics are repeated until a satisfactory way out is discovered or the stimulation proves fatal

It may be said the Slipper Animalcule has but one answer to every question but there are many Protozoa (one celled animals) which have several enregistered reactions When there are alternative reactions which are tried one after another, the animal is pursuing what is called the trial and error method, and a higher note is struck There is an endeavour after satisfaction, and a trial of answers When the creature profits by experience to the extent of giving the right answer first, there is the beginning of *learning*

Professor H S Jennings, in describing the simple and effective behaviour of the Slipper Animalcule, Paramœcium (a single-celled animal) says "It constantly feels its way about, trying in a systematic way all sorts of conditions, and retiring from those that are harmful Its behaviour is in principle much like that of a blind and deaf person, or one that feels his way about in the dark It is a continual process of proving all things and holding to that which is good" It is a good example of the "trial and error" method

Among simple multicellular animals, such as sea anemones, we find the beginnings of reflex actions, and a considerable part of the behaviour of the lower animals is reflex That is to say, there are laid down in the animal in the course of its development certain prearrangements of nerve cells and muscle cells which secure that a fit and proper answer is given to a frequently recurrent stimulus An earthworm half out of its burrow becomes aware of the light tread of a thrush's foot, and jerks itself back into its hole before any one can say reflex action' What is it that happens?

Certain sensory nerve cells in the earth worm's skin are stimulated by vibrations in the earth, the message travels along a sensory nerve fibre from each of the stimulated cells and enters the nerve-cord The sensory fibres come into vital connection with branches of intermediary, associative, or communicating cells, which are likewise connected with motor nerve cells To these the message is thus shunted From the motor nerve cells an impulse or command travels by motor nerve fibres, one from each cell, to the muscles, which contract If this took as long to happen as it takes to describe, even in outline, it would not be of much use to the

* *Life* by Sir Arthur Shipley

After a photograph taken by A. H. Pratt

THE FLOWER GARDEN OF THE GARDENER BOWER BIRD

The building of the bower and the laying out of the garden justify us in describing the bird as an instinctive architect and gardener. The bower is skilfully constructed of dead twigs supported in the centre by a cone of interwoven mosses. Directly in front of the bower there is a miniature meadow of soft moss kept smooth and free from grass, weeds and other unsightly objects. This green carpet is scattered with blue, yellow and red flowers and decorated with little heaps of brightly coloured seeds and fungi. The male bird is seen about to add another ornament to the beautiful little arbour in which he dances and pays court to his mate. These bowers have nothing to do with the nest of the bird, which is a quite ordinary one on the branch of a tree.

earthworm But the motor answer follows the sensory stimulus almost instantaneously The great advantage of establishing or enregistering these reflex chains is that the answers are practically ready made or inborn, not requiring to be learned It is not necessary that the brain should be stimulated, if there is a brain, nor does the animal will to act, though in certain cases it may by means of higher controlling nerve centres keep the natural reflex response from being given, as happens, for instance, when we control a cough or a sneeze on some solemn occasion The evolutionary method, if we may use the expression, has been to enregister ready made responses, and as we ascend the animal kingdom, we find reflex actions becoming complicated and often linked together, so that the occurrence of one pulls the trigger of another, and so on in a chain The behaviour of the insectivorous plant called Venus' Fly trap when it shuts on an insect is like a reflex action in an animal, but plants have no definite nervous system

Tropisms

A somewhat higher level on the inclined plane is illustrated by what are called "tropisms," obligatory movements which the animal makes, adjusting its whole body so that physiological equilibrium results in relation to gravity pressure, currents, moisture, heat, light, electricity, and surfaces of contact A moth is flying past a candle, the eye next the light is more illumined than the other; a physiological inequilibrium results, affecting nerve cells and muscle cells, the outcome is that the moth automatically adjusts its flight so that both eyes become equally illumined, in doing this it often flies into the candle

It may seem bad business that the moth should fly into the candle, but the flame is an utterly artificial item in its environment to which no one can expect it to be adapted These tropisms play an important role in animal behaviour

The distinction between a reflex movement and a tropism is that in the one case it is a movement of a part of the body, and in the other, a tropism, the movement and position of the body as a whole may be affected Moreover, in tropisms the *direction* of the movement is determined by the direction of the stimulus, as when the young eels swim persistently up-stream

§ 2

INSTINCTIVE BEHAVIOUR

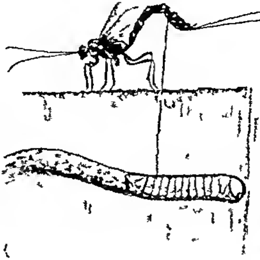
ON a higher level than reflex movements and tropisms is *instinctive* behaviour, which reaches such remarkable perfection in ants, bees, wasps, and spiders as to be beyond the scope of our understanding The behaviour of these creatures is predominantly instinctive, and the perfection of their amazing achievements, social economy and mode of behaviour is one of the marvels of life Man's supreme boast is his faculty for reason, but passing wonderful, too, and more puzzling, is instinct in its highest manifestations If in man's reason we see the peak point of evolution, in creatures like bees and ants we see the highest manifestations of instinct

Instinct and intelligence are not to be regarded as two successive stages of evolution, although it would seem that intelligence of a sort sometimes plays a part, instinct and intelligence may commingle

The subject is a difficult one There are authorities (1) who do not regard instinct and intelligent behaviour as two successive stages, they hold that instinct and intelligence are on quite different lines of evolution, (2) other investigators regard instinctive behaviour as quite inseparable from intelligent behaviour, and (3) others rank instinctive behaviour as closely comparable to chains of reflex actions, (4) there is little ground for the assumption that instinct is "lapsed intelligence"

If we are out and out evolutionists we must believe that all kinds of living beings had a common origin, and that there never was any such thing as a special creation of different species In the beginning, then, the potentiality of all the characteristics and qualities which mark all the various living creatures to day were present in the first living organisms

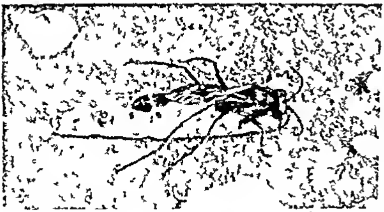
PROVIDING FOR THE YOUNG IT WILL NEVER SEE



[Photo J. J. Ward

[J. J. Ward

Ichneumon flies provide for young they will never see by laying their eggs on the grubs of wood boring insects. The grubs are in the heart of the tree and the ichneumon fly reaches them by piercing the tree-trunk with its long tail-like ovipositor. By some means it locates the presence of the grubs. It then thrusts its ovipositor into the wood to reach the grub as shown. The ovipositor has relatively the rigidity of fine steel and is inserted into the wood by means of a series of pushes. The eggs of the *ichneumon fly hatch inside the grubs and the young ichneumons devour them. Thus they are provided* with a living larder before they are born.



[Photo H. Ba n

THE CASE OF THE WASP

Solitary wasps stock nests with paralysed caterpillars which provide food for the young wasps which they will never see. When the mother wasp catches her caterpillar she stings it usually three times in three strategic points in the nervous system, the result being that the caterpillar is incapable of movement but remains alive until the larva of the wasp is ready to devour it. Meantime the mother wasp has gone.

The mother wasp is shown dragging a paralysed caterpillar to a nest.

[Photo Hugh Main

(Left.) The paralysed caterpillar lying in a nest with the eggs of the wasp deposited on it.

(Right.) Nine days later the hatched-out larva has nearly consumed the caterpillar.

[Photo Hugh Main

The flowering of that potentiality in the lower animals is Instinct, and in the highest, Man, it is Reason, which means conceptual inference or working with general ideas Somewhat between the two, Instinct and Reason, is intelligence Intelligence means perceptual inference, putting two and two together, appreciating relations of things, making a simple judgment But intelligent behaviour, we are to believe, is not simply an evolutionary advance on instinctive behaviour, the two are divergent processes of evolution Man prides himself on his intelligence and Reason The bee and the ant are entitled to boast of the achievements of instinct Many animals also show intelligence or reasoning, but Man alone has Reason All we can say is that instinct is a fundamental characteristic of the being, the outcome of the creature's own constitution, it was the nature of the first creature to obey its "instinctive" impulses

§ 3

The Bees

But what an amazing evolution that these innate impulses, whether or not they arose from the mere "answering back" or automatic reaction to outer stimuli, should have in the course of generations resulted in such a miracle of wonders as a purely instinctive creature illustrates! Think of the beehive Just to refresh our memory of what our own eyes can see let us give a short description of the beehive

We know that the social life of bees is more complicated than that of any animal except man, and its meaning is not fully understood Everywhere there is division of labour, the needs and welfare of the community and not of the individual is the imposed rule A beehive is a well ordered city, outside its walls we see a constant stream of bees coming and going, workers setting out on foraging expeditions, some bring back full sacs of honey to add to the store, others pollen neatly packed in the "baskets" on their hind legs, others have been to the pools in search of water, house bees take charge of the spoils and pack them away in the storehouse of the combs Bands of other workers carry out their respective duties, some clean out and prepare the cells to receive new eggs, some are in charge of the nurseries feeding the young, others making wax or building new combs, others are repairers, cleaners and sanitary workers keeping the hive clean and removing corpses, some act as fanners, ceaselessly beating their wings to ventilate the hive and keep the air fresh, others act as sentries or guards, keeping watch day and night, the sentries examine every bee that alights at the entrance and challenges every stranger who has no lawful business in the hive

"Thus there is a wonderful division of labour or allotment of tasks within the bee community, but the different jobs are not carried out by different worker-castes, as was at one time supposed, but are allotted to different periods in the life-history"

These are but a few examples of the extraordinary capacities of bees 'It will be observed," writes Shipley, "that the life of the whole colony is based on the principles of pure socialism, and that the social system is superior to ours There is no unemployment in a hive, there are no strikes, no lock outs Except the drones every one works continuously and at high pressure A vast majority of the bees live as workers, entirely renouncing individual rights in their effort to continue the swarm—to make sure that another queen bee may always be ready when her predecessor dies Self preservation and self propagation are completely transcended that the swarm—the social unit—may be continued

"The constant sense of mutual help, of self-sacrifice for the future race, is the dominating characteristic of all bees, and there is something that Maeterlinck calls the 'spirit of the hive,' which in some way guides, directs, and controls the work of this strange, self sacrificing community Here there is no private property" * All this we call instinct, in man we might call it rational behaviour, it is "instinct" in the bee because there is no forethought in what it does, it does not know rationally what it is doing It is no less remarkable for that

* *Life*, by Sir Arthur Shipley (Cambridge Press)

After all, can any naturalist tell us what the drama of the bee hive means? No doubt it is instinct, or instinct mainly, that characterises their behaviour, but how are we to picture the racial progress that has its culmination in the marvels of the bee hive and the ant community?

Unanswered Questions

Are we to suppose that all the achievements, all the social life of bees and ants have resulted from impulsive experimenting, with no kind of conscious intelligence behind it, that there has been merely an enregistration of those lines of behaviour that have proved profitable?

If instinct is founded on a store of "memories" of past generations, or experiences built up in the evolution of a long line of ancestral stock it would be revealing if we had the full historical story before us What kind of experience would that be that accounts for the instinct of such little geniuses as ants, bees, and wasps as we see them to day? How has this wonderful socialistic life come about—a community of insects, as Shipley says, "that rivals in complexity and in division of labour anything that we meet with in human communities"? Can we then think disparagingly of instinctive behaviour in comparison with intelligent or rational behaviour? Can we form any idea of how the behaviour of these purely instinctive creatures, and the amazing achievements communal life, and the perfect organisation, which never cease to excite our wonder, can have arisen without help from a rational or intelligent faculty? Reason and intelligence it would seem, are not the only ways of "knowing" Every investigator has to admit his inability satisfactorily to explain either the social life of bees or that of the ant community But there is no other word for it except Instinct

Maeterlinck believes that bees give proof of understanding but he adds, "my curiosity would not be less were all that they do done blindly" Their "reason and moral sense" must belong to a world entirely different from our own They have other means of "knowing" than that which comes by reason and intelligence The mystery to Maeterlinck lies in what he calls the "spirit of the hive"

As to that, let us take but one illustration—and let the illustration be the swarm, one of the strangest events in the life of the honey bee Maeterlinck calls it a "heroic renouncement," "a great immolation to the exacting gods of the race," a sacrifice of self for others It is the spirit of the hive that ordains the swarm

He says "It is not like the special instinct that teaches the bird to construct its well planned nest, and then seek other skies when the day for migration comes, nor is it a kind of mechanical habit of the race, or blind craving for life, that will fling the bees upon any wild hazard the moment an unforeseen event shall derange the accustomed order of phenomena" On the contrary, the "spirit of the hive" is masterful and is obeyed as by "an alert and quick-witted slave, who is able to derive advantage even from his master's most dangerous orders"

The queen, the workers, the drones obey the "spirit of the hive" as if governed by some great duty Everything is done not for the good of a particular individual but for the welfare of the race In a general way swarming may be described as a migration from a well peopled hive but naturalists tell us that "it would be too simple to say that it is merely the outcome of overcrowding" It is a mystery

Let us quote Maeterlinck's words, romantic, but accurate enough as a general description "It is the spirit of the hive that fixes the hour of the great annual sacrifice to the genius of the race the honour that is of the swarm, when we find a whole people, who have attained the topmost pinnacle of prosperity and power, suddenly abandon to the generation to come their wealth and their palaces, their homes and the fruits of their labour, themselves content to encounter the hardships and perils of a new and distant country This act, be it conscious or not, undoubtedly passes the limits of human morality Its result will sometimes be ruin, but poverty always, and the thrice-happy city is scattered abroad in obedience to a law superior to its own happiness Where has this law been decreed, which, as we shall soon find, is by no means as

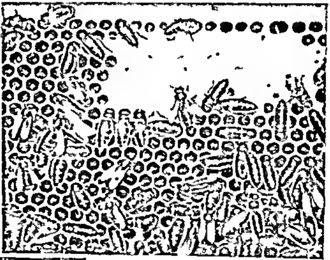
THE MARVELLOUS "SOCIAL" INSTINCT OF BEES

Bees form a perfect social community, each individual being completely subordinate to the mysterious "spirit of the hive." The cluster of bees on the right are gathered round the gates of the city, some of them are soldiers on guard ready to attack intruders, others are foragers of food. There are also bees ventilating the hive by fanning the air with their wings.

The "swarm" (below) has been figuratively described by Maeterlinck as "a great immolation to the exacting gods of the race." It is not known exactly why bees swarm.

[Photo: Ellison Hawk

Photo: W. Dixon



[Photo: Ellison Hawks

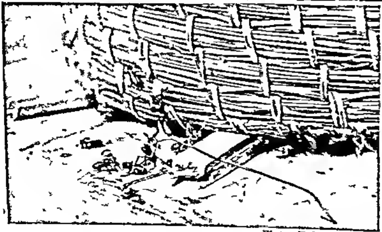


Photo: F. Martin Duncan

(Top.) Bees at work sealing over the honey cells with wax. Each of the hexagonal cells is exactly the same size and fitted in with marvellous accuracy, half the bottom of one forming half the top of another, thus ensuring that no space shall be wasted.

(Below.) Bees on guard duty: they are dragging away a flower that has been dropped at the entrance to the hive. Any obstacle or suspicious looking object is instantly removed by these vigilant policemen of the hive.

blind and inevitable as one might believe? Where, in what assembly, what council, what intellectual and moral sphere, does this spirit reside to whom all must submit, itself being vassal to an heroic duty, to an intelligence whose eyes are persistently fixed on the future?" *

Maeterlinck says that 60,000 bees out of a population of some 80,000 that form the whole population will abandon the maternal city at the "prescribed" hour, meanwhile, in anticipation, they have filled themselves with enough honey to last them for two or three days

"They will not leave at a moment of despair, or desert, with sudden and wild resolve, a home laid waste by famine, disease, or war No, the exile has long been planned, and the favourable hour patiently awaited Were the hive poor, had it suffered from pillage or storm, had misfortune befallen the royal family, the bees would not forsake it They leave it only at a time when, after the arduous labours of the spring, the immense palace of wax has its 120,000 well-arranged cells overflowing with new honey"

The hive they have left remains in possession of that part of the population which will include the young queen bees, and "the males from whose ranks the royal lover shall come, the very young bees that tend the brood cells, and some thousands of workers who continue to forage abroad, to guard the accumulated treasure and preserve the moral traditions of the hive"

Is Maeterlinck's interpretation founded on any good grounds, is it abnegation "complete and heroic," is it self-sacrifice for the progress of the race, does it surpass the morality of human beings?

The sober minded naturalist will say all these assumptions are pure fancy, and that we cannot read into the drama of the bees that far reaching, purposeful, self sacrificing principle that marks the "spirit of the hive" which evokes Maeterlinck's rhapsody Is it true that "of all the inhabitants of this globe" the honey bees "possess the highest degree of intellect after that of man"?

He writes "The aim of Nature is manifestly the improvement of the race, but no less manifest is her inability, or refusal, to obtain such improvement except at the cost of liberty, the rights and the happiness of the individual Where there is progress, it is the result only of a more and more complete sacrifice of the individual to the general interest Each one is compelled first of all to renounce his vices, which are acts of independence"

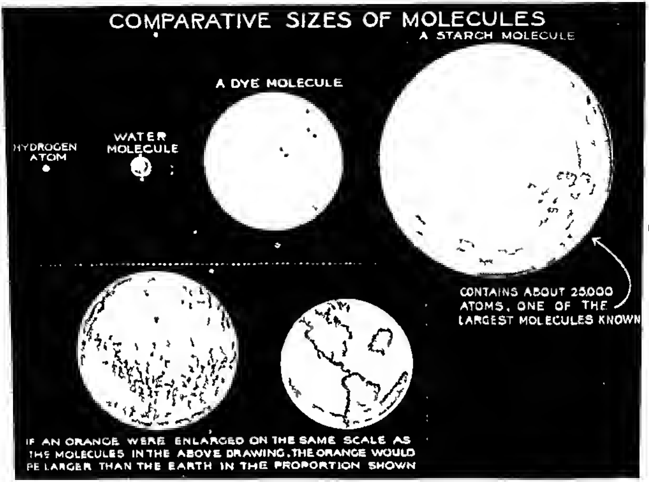
We are not for a moment advocating Maeterlinck's views We may quarrel with his philosophy of instinct, or with Bergson's, or with Lloyd Morgan's, or any other naturalist philosopher, but they are entitled to their views, for they can be neither proved nor disproved Only they must not run counter to scientific knowledge A great deal of the story of the evolution of the bee can be traced and the steps that have led through many thousands of generations of solitary bees to the society of the beehive as we see it to day, with its complexity and completeness, and its miracle of wonders

There has been a gradual transition from *solitary life to social life*, if all the stages and the actual historical sequence between the highly evolved social life of the hive bees and the life of the solitary bee are not completely traceable, the actual fact does not seem to be in doubt The evolution of social life starting from completely solitary forms has gradually led to the complex social life, as we shall see in another chapter of this book

We have recalled the social life of the bees, let us turn to the ants, and then to some interesting speculations on the properties of instinct in general

* *The Life of the Bee* by Maeterlinck

(To be continued on page 261)



Electrons or particles of electricity con pose all atoms and atoms bu ld up molecules They are of course invis ble to the una ded human eye The varying number and nature of the atoms comprising a single molecule of substance determines its size Thus a molecule of starch as shown in the above comparative diagram conta ns 25 000 atoms while a molecule of water contains two atoms of hydrogen and one atom of oxygen

universe was that an infinite number of these atoms had been moving and mixing in an infinite space during an infinite time and had at last hit by chance on the particular combination which is our universe

This was too simple and superficial The idea of atoms was cast aside only to be advanced again in various ways It was the famous Manchester chemist John Dalton who restored it in the early years of the nineteenth century He first definitely formulated the atomic theory as a scientific hypothesis The whole physical and chemical science of that century was now based upon the atom and it is quite a mistake to suppose that recent discoveries have discredited atomism " An atom is the smallest particle a chemical element No one has ever seen Even the most powerful microscope cannot possibly show us particles of matter which are a million times smaller than the breadth of a hair for that is the size of atoms We can weigh them and measure them though they are invisible, and we know that all matter is composed of them It is a comparatively new discovery that atoms are not indivisible They consist themselves of still smaller particles as we shall see But the atoms exist all the same and we may still say that they are the bricks of which the material universe is built

But if we had some magical glass by means of which we could see into the structure of material things we should not see the atoms put evenly together as bricks are in a wall As a rule, two or more atoms first come together to form a larger particle which we call a molecule Single atoms do not as a rule, exist apart from

must assume some preliminary knowledge on the part of their readers

Not one of the three subjects we have mentioned can be said to be easy to fully understand But the essential points are not difficult to grasp We propose, therefore, in this chapter to begin at the beginning and proceed step by step, and to be as simple as possible in our exposition Even when we come to the more abstruse part of our subject, any reasonably intelligent person can at least understand the significance of what he may not completely understand He can understand the results placed before him, even if he does not fully understand the method by which the results are arrived at Mathematical reasoning must be left to the mathematicians

"Not so very long ago,' says Sir J J Thomson, ' the atom was thought to be a terminus beyond which it is impossible from the nature of things to penetrate The atom was regarded as indivisible, impenetrable, eternal unaffected by heat, electricity, or any other principal agent The inside of the atom was regarded as a territory which the physicist could never enter" Well, we know now how wrong all that was The sanctuary of the atom has had its door forced to reveal the electron and passing strange phenomena

Preliminary

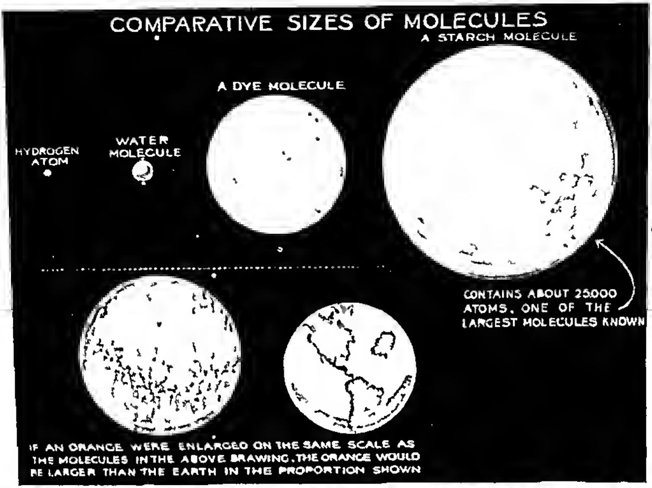
But as we have said, we shall begin at the beginning of the story, and to do that we *shall* have to go back to about the year 1898 In a preliminary word let us go back even farther than that

Most people have heard of the Oriental race which puzzled over the foundations of the universe and decided that it must be supported on the back of a giant elephant But the elephant? They put it on the back of a monstrous tortoise, and there they let the matter end If every animal in nature had been called upon, they would have been no nearer a foundation Most ancient peoples, indeed made no effort to find a foundation The universe was a very compact little structure, mainly composed of the earth and the great canopy over the earth which they called the sky They left it, as a whole, floating in nothing And in this the ancients were wiser than they knew Things do not fall down unless they are pulled down by that mysterious force which we call gravitation The earth, it is true, is pulled by the sun, and would fall into it, but the earth escapes this fiery fate by circulating at great speed round the sun The stars pull each other, but they meet this by travelling rapidly in gigantic orbits Yet we do, in a new sense of the word, need foundations of the universe Our mind craves for some explanation of the matter out of which the universe is made For this explanation we turn to modern physics and chemistry Both these sciences study, under different aspects, matter and energy, and between them they have put together a conception of the fundamental nature of things which marks an epoch in the history of human thought

Old Notions

More than two thousand years ago the first men of science, the Greeks of the cities of Asia Minor, speculated on the nature of matter You can grind a piece of stone into dust You can divide a spoonful of water into as many drops as you like Apparently you can go on dividing as long as you have got apparatus fine enough for the work But there must be a limit these Greeks said, and so they supposed that all matter was ultimately composed of minute particles which were indivisible That is the meaning of the Greek word ' atom '

Like so many other ideas of these brilliant early Greek thinkers, the atom was a sound conception We know to day that matter is composed of atoms But science was then so young that the way in which the Greeks applied the idea was not very profound A liquid or a gas, they said, consisted of round smooth atoms which would not cling together Then there were atoms with rough surfaces, ' hooky ' surfaces and these stuck together and formed solids The atoms of iron or marble, for instance, were so very hooky that once they got together, a strong man could not tear them apart The Greeks thought that the explanation of the



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This molecular movement can, in a measure, be made visible. It was noticed by a microscopist named Brown that in a solution containing very fine suspended particles, the particles were in constant movement. Under a powerful microscope these particles are seen to be violently agitated; they are each independently darting hither and thither somewhat like a lot of billiard balls on a billiard table, colliding and bounding about in all directions. The reason for this has been worked out, and it is now known that these particles move about because they are being incessantly bombarded by the molecules of the liquid. The molecules cannot, of course, be seen, but the fact of their incessant movement is revealed to the eye by the behaviour of the visible suspended particles. This incessant movement in the world of molecules is called the Brownian movement, and is a striking proof of the reality of molecular motions.

§ 2

Introductory

THE exploration of this wonder world of atoms and molecules by the physicists and chemists of to-day is one of the most impressive triumphs of modern science. The study of ordinary matter is not inferior, either in interest or audacity, to the work of the astronomer. And there is the same foundation in both cases—marvellous apparatus and trains of mathematical reasoning that would have astonished Euclid or Archimedes. Extraordinary, therefore, as are some of the facts and figures we are now going to give in connection with the minuteness of atoms and molecules, let us bear in mind that we owe them to the most solid and severe processes of human thought.

Yet the principle can in most cases be made so clear that the reader will not be asked to take much on trust. It is, for instance, a matter of common knowledge that gold is soft enough to be beaten into gold leaf. It is a matter of common sense, one hopes, that if you beat a measured cube of gold into a leaf six inches square, the mathematician can tell the thickness of that leaf without measuring it. As a matter of fact, a single grain of gold has been beaten into a leaf seventy-five inches square. Now the mathematician can easily find that when a single grain of gold is beaten out to that size, the leaf must be $\frac{1}{367000}$ of an inch thick, or about a thousand times thinner than the paper on which these words are printed; yet the leaf must be several molecules thick.

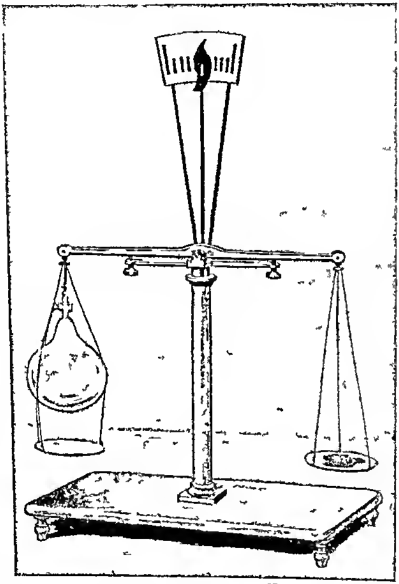
The finest gold leaf is, in fact, too thick for our purpose, and we turn with a new interest to that toy of our boyhood, the soap bubble. If you carefully examine one of these delicate films of soapy water you notice certain dark spots or patches on them. These are their thinnest parts, and by two quite independent methods—one using electricity and the other light—we have found that at these spots the bubble is less than the three-millionth of an inch thick! But the molecules in the film cling together so firmly that they must be at least twenty or thirty deep in the thinnest part. A molecule, therefore, must be far less than the three-millionth of an inch thick.

It was found next that a film of oil on the surface of water may be even thinner than a soap bubble. Professor Perrin, the great French authority on atoms, got films of oil down to the twenty-five-millionth of an inch in thickness! He poured a measured drop of oil upon water. Then he found the exact limits of the area of the oil sheet by blowing upon the water a fine powder which spread to the edge of the film and clearly outlined it. The rest is safe and simple calculation, as in the case of the beaten grain of gold. Now this film of oil was probably at least two molecules deep, so a single molecule of oil may be less than a fifty-millionth of an inch in diameter.

Innumerable methods have been tried, and the result is always the same. A single grain of indigo, for instance, will colour a ton of water. This obviously means that the grain contains billions of molecules which spread through the water. A grain of musk will scent a room—pour molecules into every part of it—for several years, yet not lose one millionth of its mass in a year. There are a hundred ways of showing the minuteness of the ultimate particles of matter,

5,000,000,000 times in every second by collisions

We have used for comparison the speed of a rifle bullet, and in an earlier generation people would have thought it impossible even to estimate this It is, of course, easy We put two screens in the path of the bullet, one near the rifle and the other some distance away We connect them electrically and use a fine time recording machine, and the bullet itself registers the time it takes to travel from the first to the second screen



[Drawing by H B Robinson

WEIGHING AIR

Modern science owes much to the system of exact and minute measurement enabling theories to be proved and which involves the use of extremely sensitive instruments This balance is so delicately adjusted that the vessel on the left scale weighs more when filled with air than when exhausted and this is comparatively speaking a crude instrument

Sensitive Instruments

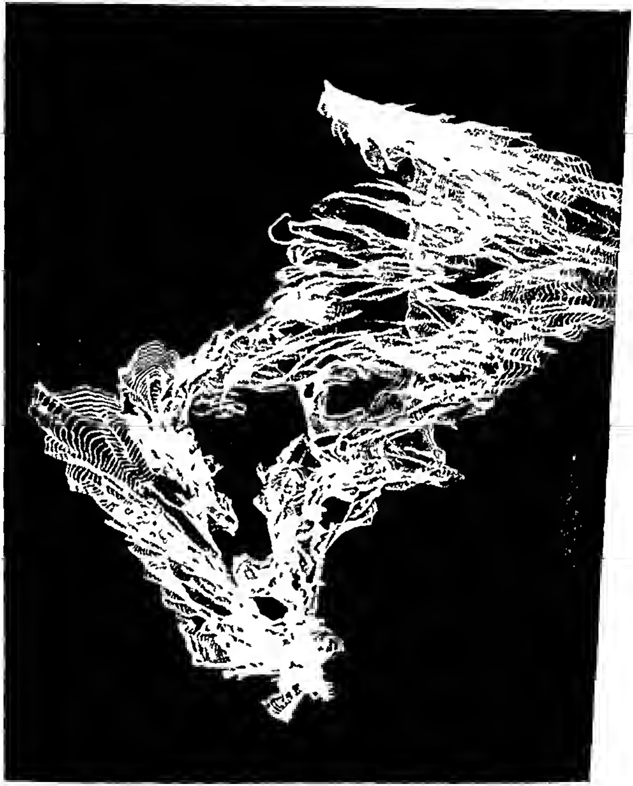
Now this is very simple and superficial work in comparison with the system of exact and minute measurements which the physicist and chemist use In one of his interesting works Mr Charles R Gibson gives a photograph of two exactly equal pieces of paper in the opposite pans of a fine balance A single word has been written in pencil on one of these papers, and that little scraping of lead has been enough to bring down the scale! The spectroscope will detect a quantity of matter four million times smaller even than this, and the electroscope is a million times still more sensitive than the spectroscope There is a heat-measuring instrument, the bolometer, which makes the best thermometer seem Early Victorian It records the millionth of a degree of temperature It is such instruments, multiplied by the score, which enable us to do the fine work recorded in these pages

§ 3

The Discovery of X-Rays and Radium

NOW let us turn to the year 1898 which is really the beginning of our present story It was the death knell (even if scientists did not know it then) to the notion that the atom was not the ultimate, indivisible, unchanging reality which it was thought to be

These wonders of the atom we have been speaking about are only a prelude to the more romantic and far reaching discoveries of the new physics—the mysteries of the electron Another and the most important phase of our



[Photo: National Physical Laboratory

A MILLION VOLT SPARK OF ELECTRICITY

A remarkable photograph illustrating the transmission of electrical power at enormous voltage. A current of electricity, whether artificially induced or in the form of lightning, is due to the release of electrons or negative charges of electricity.

exploration of the material universe opened with the discovery of radium in 1898.

In the discovery of radioactive elements, a new property of matter was discovered. What followed on the discovery of radium and of the X-rays we shall see presently. That was the first step to the discovery that atoms are not "indivisible, impenetrable, eternal" particles. We still speak of the atom, but we must not take the word now in its original Greek meaning (an "indivisible" thing). The atoms are not indivisible. They can be broken up. They are composed of particles of electricity, what are now called electrons and protons. But we shall not anticipate our story.

This discovery was the welcome realisation of a dream that had haunted the imagination of the nineteenth century. Chemists said that there were about ninety different kinds of atoms—different kinds of matter—but no one was satisfied with the multiplicity. Science is always aiming at simplicity and unity, and has now taken a long step in the direction of explaining the fundamental units of all matter. The chemist was unable to break up these elements into something simpler, so he called their atoms "indivisible" in that sense. But one man of science after another expressed the hope that there would be discovered some fundamental matter of which the various atoms were composed—*one primordial substance from which all the various forms of matter have been evolved or built up.* Prout suggested this at the very beginning of the century, when atoms were rediscovered by Dalton. Father Secchi, the famous Jesuit astronomer, said that all the atoms were probably evolved from ether, and this was a very favoured speculation. Sir William Crookes talked of "protyl" as the fundamental substance. Others thought hydrogen was the stuff out of which all the other atoms were composed.

[Photo F. A. Swaine

SIR WILLIAM CROOKES

He discovered without knowing it the rays to which Röntgen afterwards gave his name. His beautiful experiments with electric charges sent through vacuum tubes paved the way for the discovery of electrons. He described the new phenomena as a "fourth state of matter," whereas he was actually observing the flight of electrons.

The work which finally resulted in the discovery of radium began with some beautiful experiments of Professor (later Sir William) Crookes in the 'eighties.

It had been noticed in 1869 that a strange colouring was caused when an electric charge was sent through a vacuum tube—the walls of the glass tube began to glow with a greenish phosphorescence. A vacuum tube is one from which nearly all the air has been pumped although we can never completely empty the tube. Crookes used such ingenious methods that he reduced the gas in his tubes until it was twenty million times thinner than the atmosphere. He then sent an electric discharge through, and got very remarkable results. The negative pole of the electric current (the "cathode") *gave off rays which faintly lit the molecules of the thin gas in the tube*, and caused a pretty fluorescence on the glass walls of the tube. What were these rays? Crookes at first thought they corresponded to a "new or fourth state of matter." Hitherto we had only been familiar with matter in the three conditions of solid, liquid, and gaseous. These rays were something new

THE RAINBOW

The beautiful colours of the rainbow are produced by the reflection and refraction of the sun's rays by the rain-drops. Rainbows are consequently seen on the opposite side of the observer from the sun. When the sun is near the horizon the rainbow forms an arc which is nearly a semicircle. If the sun is higher in the heavens the rainbow forms a smaller arc and appears lower in the sky, but the radius of the arc is always the same. In the ordinary rainbow the red is outside and the violet inside; if there is a double rainbow the colours in the outer one are reversed.

PROFESSOR WILHELM CONRAD RÖNTGEN (E.N.A.)

The discoverer of X rays. [illegible] Crookes tube (see diagram on page 228) he found that certain of the rays given off from the cathode could penetrate a covering of black material and every kind of solid opaque substance

of the same nature as ordinary light, but of enormously shorter wave-length X-rays can now be produced in the laboratory and have proved of great value in many directions, as all the world knows, but that we need not discuss at this point Let us see what followed Röntgen's remarkable discovery.

While the world wondered at these marvels, physicists were eagerly following up the new clue to the mystery of matter which was exercising the mind of Crookes and other investigators In 1896 Becquerel brought us to the threshold of the great discovery

Certain substances are phosphorescent—they become luminous after they have been exposed to sunlight for some time, and Becquerel was trying to find if any of these substances give rise to X-rays One day he chose a salt of the metal uranium He was going to see if, after exposing it to sunlight, he could photograph a cross with it through an opaque substance He wrapped it up and laid it aside, to wait for the sun, but he found the uranium salt did not wait for the sun Some strong radiation from it went through the opaque covering and made an impression of the cross upon the plate underneath Light or darkness was immaterial The mysterious rays streamed night and day from the salt

This was something new Here was a substance which appeared to be producing X-rays, the rays emitted by uranium would penetrate the same opaque substances as the X-rays discovered by Rontgen

Discovery of Radium

Now, at the same time as many other investigators, Professor Curie and his Polish wife took up the search They decided to find out whether the emission came from the uranium itself or *from something associated with it*, and for this purpose they made a chemical analysis of great quantities of minerals They found a certain kind of pitchblende which was very "active," and they analysed tons of it, concentrating always on the radiant element in it After a time, as they successively worked out the non-radiant matter, the stuff began to glow In the end they extracted from eight tons of pitchblende about half a teaspoonful of something *that was a million times more radiant than uranium* There was only one name for it—Radium

That was the starting-point of the new development of physics about which we have now to speak From every laboratory in the world came a cry for radium salts (as pure radium was too precious), and hundreds of brilliant workers fastened on the new element The inquiry was broadened, and, as year followed year, one substance after another was found to possess *the power of emitting rays*, that is, *to be radioactive* We know to-day that there are several radioactive substances, which, as we shall see, means that *their atoms break up into smaller and amazingly energetic particles* This discovery was destined to bring about a complete change in ideas in manifold directions

§ 4

The Discovery of the Electron and how it Effected a Revolution in Ideas

What the discovery of radium implied was only gradually realised Radium captivated the imagination of the world, it was a boon to medicine, but to the man of science it was at first a most puzzling and most attractive phenomenon It was felt that some great secret of nature was dimly unveiled in its wonderful manifestations, and there now concentrated upon it as gifted a body of men—conspicuous amongst them Sir J J Thomson, Sir Ernest Rutherford (now Lord Rutherford), Sir W Ramsay, and Professor Soddy—as any age could boast, with an apparatus of research as far beyond that of any other age as the *Aquitania* is beyond a Roman galley Within five years the secret was fairly mastered Not only were all kinds of matter reduced to a common basis, but the forces of the universe were brought into a unity and understood as they had never been understood before

The Electron

Physicists did not take long to discover that the radiation from radium was very like the radiation in a Crookes tube It was quickly

WONDERFUL X-RAY PHOTOGRAPHS TELL THEIR OWN STORY

Each one of these remarkable photographs tells a different story illustrating the practical value of X rays. The foot on the left is that of a sufferer from ill-fitting boots who refused to accept a new pair until he had actually seen from the X-ray photograph that the boot did not cramp his foot.

On the right is shown a soldier's leg with needles working their way through the flesh. The soldier had been wounded in the hip by an exploding shell and portions of his "housewife" were forced into his body. The needles passed from his thigh to his calf and ultimately emerged from his foot. But before that their presence was located by X-ray photography.

What has the child swallowed? The anxieties of parents are lessened by the possibility of an instant X-ray examination to locate any object passed down the throat, in this case a halfpenny.

Photos by Ellison Hawks]

(Left)—*Another beautiful piece of X-ray detective work. The soldier's trigger finger clearly shows the bone affected by tubercular disease. Complaining of pain, the soldier was accused of malingering, but the X-ray photograph proved him to have told the truth.*

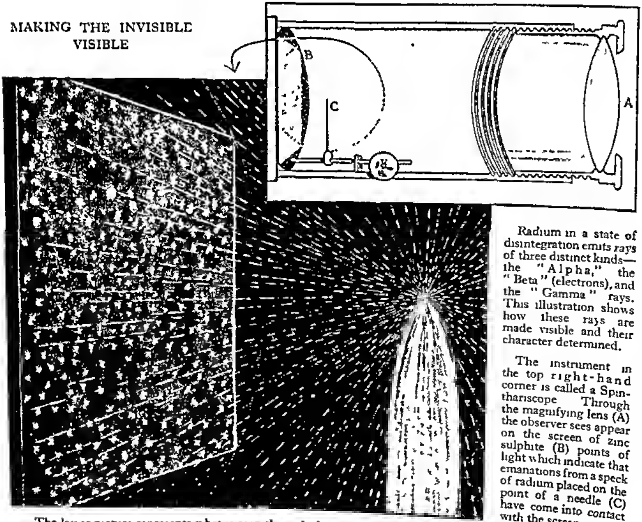
if a magnet is brought near them. And this fact led to a further discovery: to one of those sensational estimates which the general public is apt to believe to be founded on the most abstruse speculations. The physicist set up a little chemical screen for the Beta rays (electrons) to hit, and he so arranged his tube that only a narrow sheaf of the rays poured on to the screen. He then drew this sheaf of rays out of its course with a magnet, and he accurately measured the shift of the luminous spot on the screen where the rays impinged on it. But when he knows the exact intensity of his magnetic field—which he can control as he likes—and the amount of deviation it causes and the mass of the moving particles, he can tell the speed of the moving particles which he thus diverts. These particles were being hurled out of the atoms of radium at a speed which, in good conditions, reached nearly the velocity of light, *i.e.* nearly 186,000 miles a second.

Experiments

Their speed has, of course, been confirmed by numbers of experiments; and another series of experiments enabled physicists to determine the size of the particles. Only one of these need be described, to give the reader an idea how men of science arrive at their more startling results.

Fog, as most people know, is thick in our great cities because the water-vapour gathers on the particles of dust and smoke that are in the

MAKING THE INVISIBLE VISIBLE



Radium in a state of disintegration emits rays of three distinct kinds—the "Alpha," the "Beta" (electrons), and the "Gamma" rays. This illustration shows how these rays are made visible and their character determined.

The instrument in the top right-hand corner is called a Spinthariscope. Through the magnifying lens (A) the observer sees appear on the screen of zinc sulphite (B) points of light which indicate that emanations from a speck of radium placed on the point of a needle (C) have come into contact with the screen.

The lower picture represents what is seen through the magnifying lens: the radium rays are shooting out in all directions, those that fall on the screen make it glow with points of light

atmosphere This fact was used as the basis of some beautiful experiments Artificial fogs were created in little glass tubes by introducing dust, in various proportions, for supersaturated vapour to gather on In the end it was possible to cause tiny drops of rain, each with a particle of dust at its core, to fall upon a silver mirror and be counted It was a method of counting the quite invisible particles of dust in the tube, and the method was now successfully applied to the new rays Yet another method was to direct a slender stream of the particles upon a chemical screen The screen glowed under the cannonade of particles, and a powerful lens resolved the glow into distinct sparks, which could be counted

In short, a series of the most remarkable and beautiful experiments, checked in all the great laboratories of the world, settled the nature of these so called rays They were streams of particles more than a thousand times smaller than the smallest known atom The mass of each particle is, according to the latest and finest measurements, $\frac{1}{1845}$ of that of an atom of hydrogen The physicist has not been able to find any character except electricity in them, and the name "electrons" was generally adopted These electrons are the key to half the mysteries of matter Electrons in rapid motion, as we shall see, explain what we mean by an "electric current," not so long ago regarded as one of the most mysterious manifestations in nature

§ 5

The New View of Matter

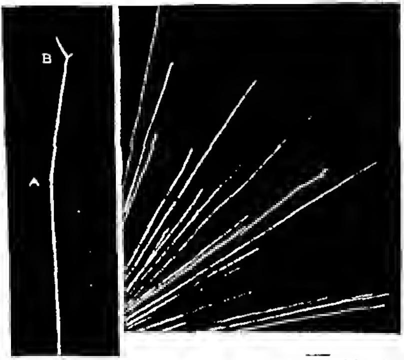
THERE is general agreement amongst all authorities upon the conclusions which we have so far given We know that the atoms of matter are constantly—either spontaneously or under stimulation—giving off electrons, and they therefore contain electrons Thus we have now complete proof of the independent existence of atoms and also of electrons

When however, the physicist tries to tell us *how* electrons compose atoms, he is on less certain ground Take the letter "o" as it is printed on this page In a little bubble of hydrogen gas no larger than that letter there are *billions* of atoms, and they are not packed together, but are circulating as freely as dancers in a ball room We are asking the physicist to take one of these minute atoms and tell us how the still smaller electrons are arranged in it Extraordinary as it may seem, mathematical physicists to day are able to give us some kind of notion about that Before we come to that subject, however, let us say a word about the different kinds of atoms

A brilliant young man of science who was killed in the war, Mr Moseley, some years ago showed that when the atoms of different substances are arranged in order of their weight, *they are also arranged in the order of increasing complexity of structure* That is to say, the heavier the atom the more electrons it contains There is a gradual building up of atoms containing more and more electrons from the lightest atom to the heaviest Here it is enough to say that when we take element after element, from the lightest (hydrogen) to the heaviest (uranium) we find a strangely regular relation between them If hydrogen were represented by the figure one, helium by two, lithium three, and so on up to uranium, then uranium should have the figure ninety two This made it probable that there are in nature ninety two elements, although they had not all been then discovered, and that the number Mr Moseley found is the number of circulating electrons in the atom of each element, that is to say, the number is arranged in order of the atomic numbers of the various elements

Every atom of matter, of whatever kind throughout the whole universe, is built up of electrons in conjunction with a nucleus From the smallest atom of all—the atom of hydrogen—which consists of one electron rotating round a positively charged nucleus (proton), to a heavy complicated atom, such as the atom of gold, constituted of many electrons and a complex nucleus, *we have only to do with positive and negative units of electricity* All matter, therefore, is nothing but a manifestation of electricity

Before proceeding farther with the study of the atom the reader should have a clear understanding of what radioactivity means As we have



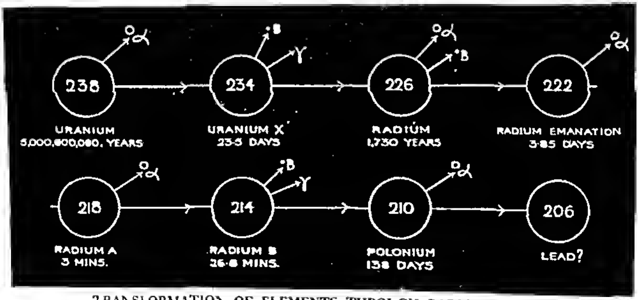
Drawing by W B Robinson] [*Photo C T R Wilson*

TRACKS OF ATOMS

Representation of the tracks of helium atoms being shot out of Radium The particles travel in a straight path until they encounter other atoms (Left) An ejected particle being deflected at A and B respectively (Right) Straight tracks of particles Helium atoms released from Radium may pass through hundreds of thousands of atoms of all sorts

said, any element that gives off rays is a radioactive substance Radioactive substances possess the property of spontaneously emitting radiations The name "radium," as we said, was given by Mme Curie to a substance which she discovered possessing great activity in emitting these rays, other substances have similar radioactive properties The element radium gives off three different kinds of rays—one of them, as we have seen, being the "Beta rays," which are now known as electrons, and which we have been discussing

In radioactive elements, such as uranium, for example the element is breaking down as it emits these rays, in what we call radioactivity we have a manifestation of the spontaneous change of elements What is really taking place is a transmutation of one element into another, from a heavier to a lighter



TRANSFORMATION OF ELEMENTS THROUGH RADIOACTIVITY

Progressive chart illustrating the spontaneous change of elements brought about by the disintegration of radioactive substances An atom of uranium by ejecting an alpha particle becomes uranium X which by the process of ejecting Beta and Gamma rays becomes radium Following the chart it will be seen that radium passes through further disintegrating stages until it becomes *transformed* into lead Every time an element changes there is loss of atomic weight Uranium begins with an atomic weight of 238 the last element shown lead has an atomic weight of 206 There is a great difference in the time taken to reach the same state of disintegration Thus uranium takes 5 000 000 000 years to reach the same state that radium A reaches in 3 minutes

The element uranium spontaneously becomes radium, and radium passes through a number of other stages until it, in turn, becomes lead Each descending element is of lighter atomic weight than its predecessor The changing process is in some cases a very slow one and in other cases is exceedingly rapid It may be that all matter is *radioactive* or can be made so

§ 6

TO continue this short recapitulation So far we have been led to think of the constitution of all matter as wholly electrical There seems to be no room for doubt about that The old notion of the indivisible, indestructible atoms of matter is dead Every one of the ninety two atoms that make up every kind of matter is *composed* of units of electricity—electrons and protons arranging themselves in definite combinations This is true of the stars in their courses, as it is true of the man and his motor car, the bee and the flower, the fish and the ocean, the bird and the air *All* matter is reducible to atoms, and all atoms to positive and negative electric charges Matter is *nothing but* electricity

(Photo J P Clark

SIR J J THOMSON

He founded a research laboratory at Cambridge and carried out there many epoch making investigations on the conduction of electricity through gases thus preparing the way for the actual proof of the existence of electrical particles by experimental as apart from mathematical methods

Electrons are all alike, wherever they come from or wherever we find them, so are protons the one a unit of negative electricity, the other a unit of positive electricity That, then, is what an atom is That was the beginning of the "new physics" The discovery has been called a revolution in our ideas of the universe, although the word revolution, in that connection, Eddington has said, should be kept to express the new views of the universe effected by Einstein's theory of relativity and the quantum theory "These are not merely new discoveries as to the content of the world, they involve changes in our mode of thought about the world" Still the theory of the electronic constitution of matter is revolutionary enough

We used to conceive the physical universe in terms of solid matter, and so it is to our senses, but the picture we have now is this solid matter dissolved "into tiny *specks floating in* the void," tiny specks that we call atoms, too small *for* the *human* eye to see And strange to say an atom is chiefly empty space, as we shall see presently It follows that any piece of matter, since it is composed of atoms, is also chiefly empty space This is an astonishing revelation, we are to imagine the void within the atom relatively as great as the void of interstellar space If the actual protons and electrons that compose a man's body could conceivably be compressed together they would amount to a scarcely visible speck But let us proceed

§ 7

HOW are we to picture an atom, since it is a thing that cannot be seen by the human eye, far less the electrons that constitute it? It was Sir Ernest Rutherford who first pictured the proton as a nucleus of the atom

round which the electron revolved at incredible speed The atom, in fact, was pictured as a sort of miniature solar system This picture is still used, but it has been modified somewhat We need not bother about that at present At the centre of this miniature solar system we are to imagine a nucleus or "sun," which is called a proton—a speck of positive electricity, this nucleus may consist of several protons, that depends on what kind of atom it is Round the nucleus, and corresponding to the planets, a number of revolving electrons, unit negative electric charges, just sufficient to balance the *positive charge of the nucleus and make the* atom, as a whole, electrically neutral The lightest and simplest element known is hydrogen, it has one proton and one electron in revolution round it In helium two electrons revolve round a nucleus, which has four times the weight of the hydrogen nucleus, and so on in a rising scale, calcium, for example, has twenty revolving electrons in its atom, and uranium ninety two

That then, is the model picture of an atom, the little "solid" atom as we used to think of it We have recently heard a good deal about the successful feat of "splitting" the atom—what does that mean? It means that *to break down or disintegrate an atom is simply to destroy its electrical balance, in other words to resolve it into its electric constituent parts*

The experiments conducted by Sir Ernest Rutherford in bombarding the nuclei or cores of the atoms of an element are among the most brilliant in the history of the search of the electron For the purpose of bombardment he used Alpha particles Sir Oliver Lodge has described Rutherford's work in the following words

"The nuclei could not be shattered, or got at in any way, by any such trivialities as high temperature, extreme cold, enormous pressures, chemical explosions, or anything of that kind They were far beyond the reach of these trifling perturbations But the projectiles fired off by radium at a speed of several thousand miles a second were not so insignificant And Rutherford arranged to bombard the nucleus of any desired atom by means of these projectiles The nuclei were targets excessively difficult to hit, because they were so ultra minute, and thousands of shots might go by them without achieving anything But then, hundreds of thousands of shots were available, any number, in fact, so that sooner or later there was bound to be a hit Briefly, the nucleus broke up and hydrogen flew out" * This is one of the most remarkable experiments ever made by man

We are told that "the atom is as porous as the Solar System" That is an astonishing thing The tiny atom, with its circulating electrons, has plenty of space in it There is plenty of room for the electrons to move, relatively *speaking, the atom is as porous as the solar* system A miniature solar system, we called it, like the stellar universe, it has its empty spaces, and unbelievable though it may seem, we are to imagine void spaces in the atom relatively as vast as those that lie between the planets and the sun

But, it may be asked, if atoms are so infinitely small as to be unobservable by the ultra-microscope, how can the even smaller electrons be detected as they are shot out of the atom as in the experiment of Sir Ernest Rutherford? The description of how electrons are detected, given in another connection on page 239 indicates the answer to this question The physicist is dealing with things that are not visible to the eye, except in certain phenomena that can be experimentally observed The major part of what goes on inside the atom is based on mathematical reasoning, but not altogether, as we shall see

§ 8

The Quantum Theory

LET us return to the story of the electron and we come now to one of the most difficult problems in physics—the Quantum Theory The developments relating to the electron and the quantum theory belong, approximately, to the last dozen years The quantum theory has become one of the most important theories in physics

* Sir Oliver Lodge's *Atoms and Rays*

AMAZING PHOTOGRAPHS PROVE THE REAL EXISTENCE OF ELECTRONS

Experiments have long been made with a view to obtaining concrete evidence of the existence of electrical particles far too minute to be detected even by a microscope. Sir J. J. Thomson was one of the first to determine the nature of an electrical charge by purely experimental methods. He succeeded in showing that electrical particles leave a track when they pass through clouds of gas under certain conditions. More recently, C. T. R. Wilson perfected this method and actually succeeded in photographing the tracks of Alpha and Beta particles. He did this by passing an electric current through a chamber containing water-vapour in a certain state of condensation and which he cooled and illuminated simultaneously, thus retaining a picture of the momentary state of the air.

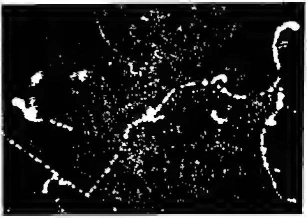


Fig. 1

Fig. 1 shows the collision of an electron with a nucleus of an atom and other electrons. The chances of a head on collision between an electron and a nucleus are very small indeed, so that this picture represents a rare accident in the world of the atom. The white lines are not, of course, the actual electrons but the impression of their rapid passage through droplets of water just dense enough to make them visible. It is impossible to conceive the rate at which electrons travel: their velocity has been mathematically computed to be almost that of light, i.e. nearly 186,000 miles a second.

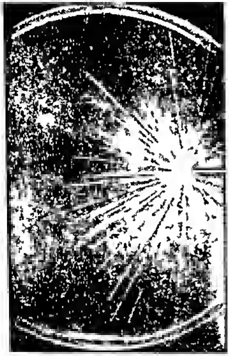


Fig. 2

Fig. 2.—A beautiful photograph showing a fragment of radium shooting out Alpha rays in all directions within the Wilson Cloud Chamber. The Alpha rays given off by such metals as radium and uranium are atoms of helium gas, or rather, the nuclei of such atoms, shot out at the rate of 12,000 miles per second.

Fig. 3.—Track of a narrow beam of X rays (entering from the right hand side of the picture) passing through air and liberating electrons from atoms. The X rays themselves are not visible: the tortuous paths are of electrons which the X rays have shot out of some of the atoms they have encountered.

Figs. 1 and 3 reproduced by courtesy of Lord Rutherford, and Mr. C. T. R. Wilson. Fig. 2 reproduced by courtesy of Messrs. G. Bell & Sons, Ltd., and Mr. C. T. R. Wilson.

Fig. 3

A REMARKABLE PHOTOGRAPH OF LIGHTNING [Topical Press

The phenomenon of lightning is due to the contact of clouds highly charged with electrons or to a discharge of electrons from a highly charged cloud to the earth which may be considered as an immense reservoir of electrons

tion are discontinuous Each individual atom emits or absorbs energy jerkily The steady radiation we perceive is due to the combined effects of immense numbers of atoms

We have previously said that radiation is a generalised name for light, and all light is measurable by wave lengths If we pursued this subject of the quantum theory into its still higher reaches we should see how it has complicated the question of the nature of light It is not a new theory of light, and is in conflict with the old established view, which held that light was a continuous vibration that is the wave theory The new view suggested now is that light is made up of " atoms " or tiny packets, or " quanta," of energy And the quantum theory and the wave theory appear to be in contradiction Light appears to be both a stream of particles and a train of waves The " wave " may partake of the nature of a particle Indeed, the word " wavicle " has been invented Light may have a dual nature or structure It behaves as if it was both particles *and* waves The old wave theory explained the propagation of light, but there are recently discovered phenomena that the wave theory does not explain The quantum theory, we are told, explains these important phenomena, but the quantum theory does *not* explain the phenomena the old wave theory explains

The conflict of opinion thus raised between the corpuscular theory of light and the wave theory has not been resolved

In this connection we may quote a passage from Eddington " Light, we will say, is an entity with the wave property of spreading out to fill the largest object-glass and with all the well known properties of diffraction and interference; simultaneously it is an entity with the corpuscular or bullet property of expending its whole energy on one very small target We can scarcely describe such an entity as a wave or as a particle; perhaps, as a compromise, we had better call it a 'wavicle'" Conceivably *electrons* may be both particles *and* waves, according to the operations involved in the way they are observed

The electron may have a dual structure, as light is supposed by some physicists to have a dual structure The electron travels accompanied by a train of waves, and vibrating in consonance with the waves In some respects it looks as if it were a sort of wave-system

The " quantum " of light shot out by an atom—say an atom in a distant star—also has this curious combination of properties It can be proved, by an examination of star images in a telescope, that a single quantum must be large enough to spread over the entire lens of the telescope It must also, as other experiments show, be small enough to enter an atom These paradoxical facts have suggested the apparently wild idea that the quantum does not, properly speaking, belong to space and time as we know them Modern science seems to be on the verge of some great revelation of which we have obtained, hitherto, only the most perplexing glimpses Let us see

(To be continued on page 285)

BOOK III—(Continued from page 196)

THE DEVELOPMENT OF RELIGIOUS THOUGHT AND MODERN DISCOVERY

CHAPTER II—(*Continued*)

THE RELIGION OF ANCIENT GREECE—(*Continued*)

National Museum Naples] [*Anderson*

PLATO (427–347 B C)

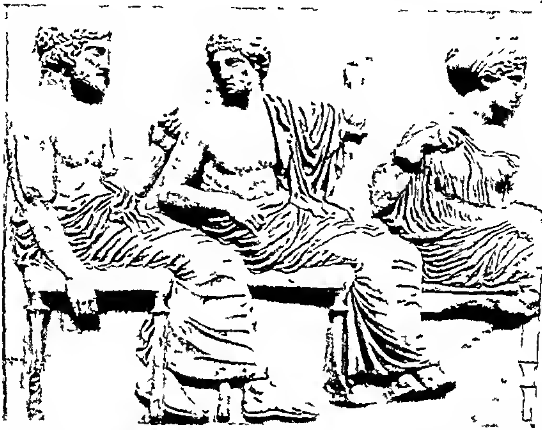
Without what we call our debt to Greece we should have neither our religion nor our philosophy nor our science nor our literature (Dr Inge)

Platonism is still a living influence The philosophy of Plato in its important bearing on religious belief will be fully explained in this work

§ 1

THE gods of tradition had been dethroned, they are no longer gods in whom any one believes as a hard fact In the great funeral speech of Pericles there is not, as Gilbert Murray remarks, any mention of the name of a single god Mythology begins to be replaced by allegories In the beginning Zeus "with the lightning in his hand" was the great Sky god, the highest god, Apollo, "whose beams were golden arrows," the Sun god, Athena a warrior goddess, protecting her own city of Athens, and so with other gods controlling special realms We must not think of allegory, says Professor Murray, as a late post classical phenomenon in Greece It goes back to the sixth century B C or farther back than that Here again is a difficult study to be pursued in the works of the specialists, we are merely trying to convey a general impression Sir Gilbert says the Olympians "have two special regions which they have made their own mythology and allegory The mythology drops for the most part very clearly out of practical religion The myths survive chiefly as material for literature, the shapes of the gods themselves chiefly as material for art They are both of them objects not of beliefs, but of imagination As the more highly educated mind of Greece emerged from a particular, local, tribal conception of religion, the old denationalised Olympians were ready to receive her"

By the fourth century B C the average Athenian must have recognised what philosophers had recognised long before, that a religion, to be true, must be universal and not the



[Mansell

Part of a frieze representing three deities Poseidon Dionysus and Demeter and forming an interior decoration of the Parthenon at Athens rebuilt after the Persian invasion in the age of Pericles *Greek sculpture of this period (480–430 B C) reached its highest level and was notable for its simplicity and directness*

privilege of a particular people They (the gods) are artists dreams ideals allegories they are symbols of something beyond themselves They are gods to whom doubtful philosophers can pray with *all a philosopher's due caution* as to so many radiant and heart searching hypotheses They are not gods in whom any one believes as a hard fact

The gods were but an image a symbol or merely metaphors just as all your creeds and definitions are merely *metaphors*, attempts to use human language for a purpose for which it was never made the truth lies beyond them, a thing not conquered but still to be pursued *Now* we see what Socrates meant when at his trial he said to his accusers I do believe in the gods as no one of my accusers believes in them '

Something like this considers Professor Murray, was the character of the Olympian religion in the higher minds of later Greece While the old Olympian religion did in fact stir the imagination of men and fill their spirit with lofty inspiration still to the educated thinking man the gods were not the reality, but regarded only *as metaphors or symbols* picturing *an ideal or mystic reality* As the most beautiful image carved by man was not the god but only a symbol *to* help towards conceiving the god, *so* the god himself when conceived was *not the reality* but *only a symbol to help towards conceiving the reality* The paganism of such men was no primitive crude realism, it was permeated by allegory and poetical imagination Meanwhile they issued *no* creeds that contradicted knowledge *no* commands that made man sin against his inner light All was ideal poetical, mystical Professor Murray *quotes, from an ancient author*, a beautiful ancient defence of idols which is too long to give here *

* *See Four Stages of Greek Religion*

Just as the early tribal god Yahweh of the Hebrews developed into the one and only God, so, analogously, developed the religious ideas of the educated Greek into an exalted vision The analogy may stand, even if monotheistic ideas came to Greece rather through the abstractions of philosophy

It is Plato who interprets Socrates, for Socrates never wrote anything It may be that to day some advanced modern theologians who hold new and disturbing views about traditional Christianity are very guarded in putting them before a popular audience for fear of being misunderstood So it was of old The doctrines of Socrates had an effect on undisciplined and unprincipled minds of his day They found a licence for an unworthy freedom He had a genius for destructive criticism There are writers who hold that Socrates was not unjustly condemned by his accusers (a majority of sixty found him guilty) From the point of view that his propaganda was doing little good in the Athenian state, Bury says "they were perfectly right, his spirit and the ideas that he made current were an insidious menace to the cohesion of the social fabric, in which there was not a stone or joint that he did not question In other words, he was the active apostle of individualism, which led in its further development to the subversion of that local patriotism which had inspired the cities of Greece in her days of greatness" In Socrates' day, as in St Paul's day, and as in our own day, some things may be lawful but not expedient

But Socrates felt that he was fulfilling a religious vocation, convinced that only by intellectual labour can a vision of truth be attained No greater evil can befall a man than to do wrong, goodness is knowledge, the sure foundation of conduct is the knowledge of the principle of goodness in itself and in its application Socrates has been called the first champion of the supremacy of the intellect as a court from which there is no appeal, but he was no irresponsible kind of rebel, there was one authority he acknowledged and to that he held whatever the consequences He set forth a *standard* of truth; we have the Socratic method for arriving at truth and detecting the causes of error He did not write, he did not preach, he only discussed The burden of his philosophy is—the good is the useful, virtue is happiness, virtue is the knowledge of right living, the only possible virtue is true knowledge "His death set a seal upon his life," a martyr to truth-seeking

§ 2

Plato and Aristotle

As we have said, we shall hold over for discussion in more detail the doctrines of Plato and the work of Aristotle Meantime, as we all know, both are landmarks in world-history and the world of thought We are merely indicating here the spirit of the age On this point Mr H G Wells sums up Plato thus "So far mankind has been living by tradition under the fear of the gods Here is a man who says boldly to our race, and as if it were a quite reasonable and natural thing to say, 'Take hold of your lives Most of those things that distress you, you can avoid, most of those things that dominate you, you can overthrow You can do as you will with them'"

Like Socrates, the philosophy of Plato is always a "way of life" He was the first great idealist The knowledge he sought was that knowledge which would reveal the ultimate truth of the universe as ideal goodness We shall see what his doctrine of Ideas means when we come to that subject later on It has been said that "if a man's life can be valued by what he *thinks* and what he *lives for*, Plato must rank among the saints of human history" It was Nietzsche who spoke of Plato's ideals as "Christianity before Christ" And it is Bury who writes "Plato has left us the first systematic defence of Theism we know of, and it is based entirely on his doctrine of soul as the self-moved mover"

Aristotle's was perhaps the greatest brain of the whole world He was the first to realise the necessity of ordered knowledge, his whole life was devoted to gathering facts, to classifying and ordering of knowledge We can say that

[Photo: Alinari

THE PARTHENON

The Parthenon, surmounting the stately rock of the Acropolis, is the graceful landmark of Athens. This wonderful pagan temple has served in its time as a Christian church; prayers have ascended from it to Zeus, to Allah, and to Christ. The Elgin Marbles in the British Museum were brought from the Parthenon.

Courtesy of Le d 1 t Gallery] [*Mansell*

THE RETURN OF PERSEPHONE

As p ctured bv S r Freder ck Le ghton One of the most beautiful of Greek myths The myth of Demeter and Persephone as acted as a sacred drama n the myster es of Eleusis The twin goddesses were personifica t ons of the fru tfulness of the earth and symbolised also the mystery of death and the hope of a bl ssful immor tal ty (See page 51)

WONDERFUL GREEK SCULPTURE

Vatican Museum, Rome] *[Anderson*

DISCUS THROWER
By Myron

Uffizi Gallery, Florence] *[Alinari*

ATHLETES WRESTLING
Ascribed to Lysippus

National Museum, Athens] *[Alinari*

ATHENA
By Pheidias

Vatican Museum, Rome] *[Mansell*

VENUS OF CNIDUS
By Praxiteles

it is not like the Persian invasion written large on the face of history, threatened Greece with a no less terrible danger This danger lay in the dissemination of a new religion, which, if it had gained the upper hand, as at one time it seemed likely to do, would have pressed with as dead and stifling a weight upon Greece as any oriental superstition Spiritually the Greeks might have been annexed to the peoples of the orient"

The Orphic Religion

Among the educated there was a new mental outlook, old time primitive beliefs were dissolving, a new intellectual life was stirring The religious mythology of tradition, originated by the epic bards was about to be transformed into a philosophy with ethical ideals behind it a reinterpretation which we might compare with the present day modernist s reinterpretation of some aspects of the traditional Christian religion Men's minds were turning to questions about the meaning of life, the existence after death what really lay behind the world of shades, 'a desire for personal contact with the supernatural'

Somewhat in this way, then, we see in the sixth century B C what are called the mystery religions coming into being The Orphic religion had a deep influence not only with the thinkers of Greece but a firm hold on the people at large There is no need for us to trace the origin and propagation of this new religion which was associated with the worship of the god Dionysus The Orphic religion took its name from Orpheus who, according to some writers, was supposed to have been born in Thrace,* soothsayers and wandering teachers travelled throughout all Greece and their mysterious teachings eventuated in the formation of Orphic

* The writer of the article on Orpheus in the *Encyclopædia Britannica* writes ORPHEUS The legendary founder of the cult known as Orphism The derivation of the name is uncertain possibly from the same root word signifying darkness What original figure human or divine lies behind the legend is unknown it seems possible however that Orpheus is the name or title of Thraco-Phrygian priest kings who may have been regarded as incarnating the god Dionysus or some similar deity and were perhaps killed by the worshippers of the god after a period of years (see Frazer, *Golden Bough* 3rd ed vi 99)

Ministry of Public Instruction Rome] [*Mansell*

STATUE OF ATHENE

An example of fifth century B C sculpture, representing the goddess Athene

brotherhoods The religion had a kind of theology of its own, and its own doctrine of the future world, it had its peculiar rites and rules of conduct The teachings were contained in a book of Orpheus which circulated fairly widely among the common people Professor Bury writes, "the Orphic religion might almost be described as based on three institutions the worship of Dionysus, the mysteries connected with the gods of the underworld, and the itinerant prophets, but Dionysus, the underworld, and the art of the seer and purifier, all acquired new significance in the light of the Orphic theology"

The Orphics created a cosmogony which we need not describe here, nor the mystic brotherhood, which observed certain rules and rites of the cult We are merely indicating certain ideas which marked the progressive steps to religious thought of a later day "In its symbolism the mysticism of the age felt its way towards union with the Unseen In their higher forms Orphic ideas penetrated Greek idealist philosophy, and through it Christianity, in their lower forms they passed into, and reinforced, every ignorant superstition for centuries" (Dr Dampier Whetham)

Eleusian Mysteries

We must distinguish, as we have said between the Olympian gods, represented by Zeus and Apollo and the mystery divinities represented by the nature-god, Dionysus They are different orders of being The Olympians, as we have seen, were idealised superhuman beings with whom humans could have no personal communion In the mystery religions the divinities were approachable by the initiated in a state of emotional ecstasy and mystic rites Eleusis was famous as the chief seat of Eleusian mystery religions and of the worship of nature divinities, such as Demeter and the deities associated with her Eleusis was close to Athens, and the central part of Athenian religious life

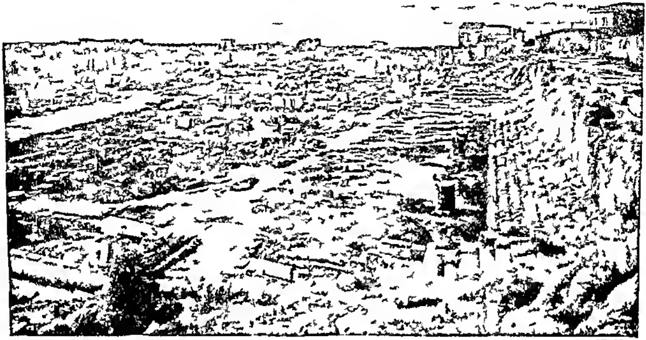
The reader who wishes a full account of how the mystery religions arose in Greece should consult Miss Harrison's well known work on the Study of Greek Religion, *Prolegomena to the Study of Greek Religion* (Cambridge University Press)

The whole subject of the mystery religions is too big and involved to go into here in detail, they are mostly more or less mysteries still Some account must be given of the mystery cult of Eleusis, for the Athenian state gave its especial patronage to the Eleusinian cult, "it was in a way (says Dr Bevan) part of the public religion of the Athenian state It continued to be a mystery religion, in so far as no Athenian received initiation except by his individual choice, and it was gross impiety for an initiated Athenian to divulge what he had seen to his uninitiated fellow citizens"

Much religious emotion and ritual centred round the famous Eleusis festivals, which consisted of sacramental feasts and offerings, purifications and mystic performances practised by congregations of such persons as had been initiated Of the true nature of some of those religious mysteries the modern world still knows very little, quite a literature has been devoted to them In the secret rites it would seem that only those could take part who had been initiated The ceremony must never be revealed by the initiated on pain of divine vengeance The initiated were supposed to be under the care of the deities, they enjoyed happiness and security, and these benefits were extended beyond the grave To the initiated was given the assurance, 'Happy and blessed one, Thou shalt be a god instead of a mortal" To them, to be a god meant to be immortal The initiatory ceremonies were to purify the soul of the worshippers

The Mysteries were largely connected with the cult of the deities of the underworld, and there was introduced to them a new doctrine touching the state of souls in the life beyond the grave The Orphics created a cosmogony, which the reader will find explained in books like Miss Harrison s

It is of little consequence, except to the keen student of the evolution of religion, to speculate about the origins and the forms which the Greek mystery religions took Our leading authority, Sir James Frazer, speaking about the Eleusinian mysteries and the myth of Demeter and Persephone, says that 'the association of the Corn Goddess at Eleusis with the mystery of death and the hope of a blissful immortality' is sufficient to explain the origin of the religion, its ritual and



ELEUSIS AND THE MYSTERY RELIGIONS [E.N.A.

The Telestrion or interior of the Temple of Demeter at Eleusis. It was here that elaborate performances connected with the Greek mystery religions described in the text took place. This phase of religious worship followed the period of more or less unregulated belief in the Olympian gods, and was concerned with sacrificial rites, evocation of the world of the unseen, and other obscure mysteries in which only the initiated could take part.

the evocation of the world unseen.* On to the original stock in the course of long religious evolution were grafted high moral and spiritual conception. The legend of Demeter and Persephone was associated with certain cults, and at Eleusis the *chthonian* (underworld) cult was notable for a new doctrine concerned with the state of souls after death.

* Surveying the evidence as a whole we may say that from the myth of Demeter and Persephone, from their ritual, from their representations in art, from the titles which they bore, from the offerings of first fruits which were presented to them, and from the names applied to the cereals, we are fairly entitled to conclude that in the mind of the ordinary Greek the two goddesses were essentially personifications of the corn, and that in this germ the whole efflorescence of their religion finds implicitly its explanation.—Frazer's *Man, God and Immortality* (Macmillan and Co.)

The Ceremonies

The Eleusinian mysteries became one of the chief festivals of the year. The ritual took the form of a representation in dumb show of the story of Persephone and Demeter, and it is supposed that mystic spells were uttered at certain moments in the spectacle. There was no system of doctrine expounded; the initiated simply took part in the ceremonies as seers. The performances lasted about two weeks, the devotees thronging to them from everywhere. They attracted the attention of the whole Hellenic world.* "The great day (writes

* The rites and festivals surrounding the worship of Dionysus are closely associated with the early development of the Greek drama. The problem of the relation between the mystery god Dionysus and

In the National Gallery London] [*Mansell*

BACCHUS AND ARIADNE
By Titian

Scenes in the mythical life of Bacchus or Dionysus a personification of wine and its exhilaration and the giver of wealth were performed at Eleusis *The myth takes different forms and the ceremonial ritual was very elaborate* (See Sir James Frazer s *The Golden Bough*)

Bury) was when they assembled in the Hall of Initiation, and sat around on the tiers of stone seats The Hierophant displayed the secret things of the worship Beside him the torch-holder, the herald, and the priest of the altar conducted the mystic ceremonies The mysteries are mysterious still, so far as most of the details are concerned Yet we may perhaps say that no definite dogma was taught, no systematic interpretation was laid on the legends, but the 'acts' were calculated to arouse men's hopes, mysterious enough to impress their imaginations, and vague enough to suggest to different minds different significances The rites gave to many an assurance of future weal and even to harder reasoners a certain sense of possibilities unknown" What the votaries got was an emotional experience fitting them for the after life 'A passion play was enacted amid the most impressive surroundings"

A detailed description of these Eleusinian rites will be found in Legge's *Forerunners and Rivals of Christianity* The mysteries, or sacred dramas, it would seem, set forth the passion, death and resurrection of some god The initiates "saw with their own eyes" an acted drama of the mythical happenings in the lives of divinities like Zeus, Demeter, Persephone, and so on They witnessed many strange things, and took part in mysterious symbolical experiences, even in a descent to the lower world Excavations at Eleusis have provided much interesting information about the great hall and buildings where the mysteries took place, without, however, adding much to our knowledge of the mysteries themselves

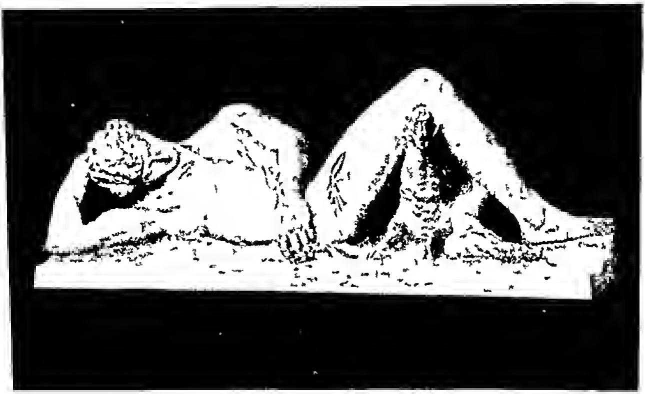
Orpheus is an intricate affair Religious convention compelled the tragic poets to draw their plots from traditional mythology from stories whose religious content and motive were already in Homer s days obsolete"

Pythagoras

Pythagoras (582–500 B.C.), one of the great figures in ancient Greece, was the founder of a philosophical sect, or moral and religious school, which exercised a profound and lasting influence. Through his travels he had come in touch with the Egyptians, the Phœnicians, the Chaldeans, the Persians, and the Jews. This is not the place to speak about the important scientific work of this great genius, but his philosophic and religious influence concerns our story, for he countenanced much of the Orphic doctrines.

Pythagoras combined such science as there was in his day with a metaphysical teaching. He held the doctrine of transmigration (rebirth) of souls, and the sect he founded adhered in many ways to the Orphic mysteries. The doctrines of philosophers in their entirety are usually too high for the common people, and in the case of Pythagoras it proved to be so. The religious note is characteristic in his scientific study, but "science and religion are not to be brought into union by a single process of juxtaposition." Gilbert Murray remarks that Pythagoras deliberately expresses himself in language which would not be understood by the vulgar and which bore a hidden meaning for his disciples.

Professor Bury lays stress on the failure of the Orphic religion and the suppression of the Pythagorean school (450 B.C.). "At the time of the fall of the Pythagoreans, the Orphic religion was no longer a danger to Greece. It was otherwise in the lifetime of Pythagoras himself. Then it seemed as if the Orphic doctrines had been revealed as the salvation which men's minds craved, and if those doctrines had taken firm hold of Greece all the priesthoods of the national temples would have admitted the new religion, become its ministers, and thereby



In the National Museum, Florence] *[Anderson*

THE DYING ADONIS

By Michelangelo

The story of Adonis is one of the best known of Greek myths; many legends attach to this god and to his death and resurrection. Frazer says: "The worship of Adonis was practised by the Semitic peoples of Babylonia and Syria, and the Greeks borrowed it from them as early as the seventh century before Christ."

[Mansell]

PYTHAGORAS AND HIS PUPILS

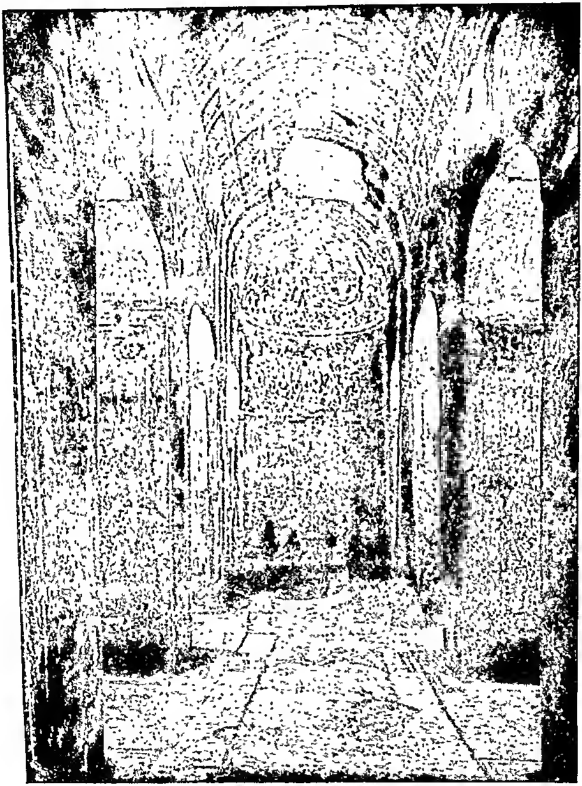
By Raphael

Pythagoras of Samos (528 500 B C) founded a community and preached doctrines founded largely on Orphism The Pythagoreans believed in the transmigration of souls and like the Orphics refrained from eating the flesh of animals The sect exercised a profound and lasting influence Plato s doctrine of the immortality of the soul owes much to the suggestions of Pythagoras

exercised an enormous sacerdotal power Pythagoras although he and his followers made important advances in science, threw his weight into the scale of mysticism, affected by both the religious and the philosophical movements he sought to combine them, and in such unions the mystic element always wins the preponderance' The Orphic teachers adds Professor Bury, would not have failed if there had not been an influential body of thinkers who kept themselves apart from these mystic ideas who refused to be diverted from the paths of reason and science For those readers who may wish to follow up this subject we commend the books we have mentioned above

Allegory and Mysticism

Generally what we have seen in the mystery cults are beliefs and ritual which at first in a crude state were connected with the life and phenomena of nature then allegorically, coming to be understood as bearing on the life of man—in life and death It was easy to establish the connection (as Dr Bevan says) since, if the rites had originally set forth such a victory of life over death as might be seen in the annual renewal of the vegetable world, the men who associated themselves with the death and resurrection of the god might well believe that by such association they too won a new life after bodily death"



[*Courtesy of The Clarendon Press, Oxford*

MYSTERY RELIGIONS AT ROME

A subterranean sanctuary of an Orphic or neo-Pythagorean community, discovered recently at Rome, near the Porta Maggiore.

We have seen that persons were officially initiated; how the initiated were given guidance, emotionally stirred, and as initiates "died with bright hopes." There is the mystic sense of superhuman powers, whose aid has to be evocated in sacred rites, in a ritualistic order, in disciplinary purifications and mystic ways of communion, to secure the ransom of the soul. A religion of allegory and vague mysticism. A mysticism that was to take more definite shape in the minds of the philosophers. The destiny of the soul was of chief interest with the Orphics. The nature of the soul was the chief inquiry of Plato. For some of Plato's ideas we go back to Orphic ideas; *Plato's own* doctrine of the soul, we are told, "owed much to the suggestions of Orphic and Pythagorean lore." The next step is free rational inquiry and intellectual speculation.

The Greek Genius

We would be wrong to picture the Greek citizens of the age of Socrates and Plato as mainly highly *educated*. Yet, it would seem that the whole people combined artistic and intellectual genius with "a big element of savagery", it was not that just a highly cultivated few lived in the midst of a barbarian populace. Let us quote from an essay by Sir Gilbert Murray, for he puts it clearly.

Borghese Museum, Rome] [*Anderson*

PLUTO AND PROSERPINE
By Bernini

Pluto, the god of the under world, was associated in the Greek mind with the darkest mysteries. No temple was raised to the Lord of Death. He carried off Proserpine (or Persephone) to be his queen in Hades. (For Persephone's return, see page 247.)

"And here I may meet an objection that has perhaps been lurking in the minds of many readers. 'All this,' they may say, 'professes to be a simple analysis of known facts, but in reality is sheer idealisation. These Greeks whom you call so 'noble' have been long since exposed. Anthropology has turned its searchlights upon them. It is not only their ploughs, their weapons, their musical instruments, and their painted idols that resemble those of the savages; it is everything else about them. Many of them were sunk in the most degrading superstitions; many practised unnatural vices; in times of great fear some were apt to think that the best 'medicine' was a human sacrifice. After that, it is hardly worth mentioning that their social structure was largely based on slavery; that they lived in petty little towns, like so many wasps' nests, each at war with its next door neighbour, and half of them at war with themselves.

"If our anti-Greek went further he would probably cease to speak the truth. We will stop him while we can still agree with him.

These charges are on the whole true, and, if we are to understand what Greece means, we must realise and digest them We must keep hold of two facts first, that the Greeks of the fifth century produced some of the noblest poetry and art, the finest political thinking, the most vital philosophy, known to the world; second, that the people who heard and saw, nay, perhaps even the people who produced these wonders, were separated by a thin and precarious interval from the savage Scratch a civilised Russian, they say, and you will find a wild Tartar Scratch an ancient Greek, and you hit, no doubt, on a very primitive and formidable being, somewhere between a Viking and a Polynesian That is just the magic and the wonder of it The spiritual effort implied is so tremendous " *

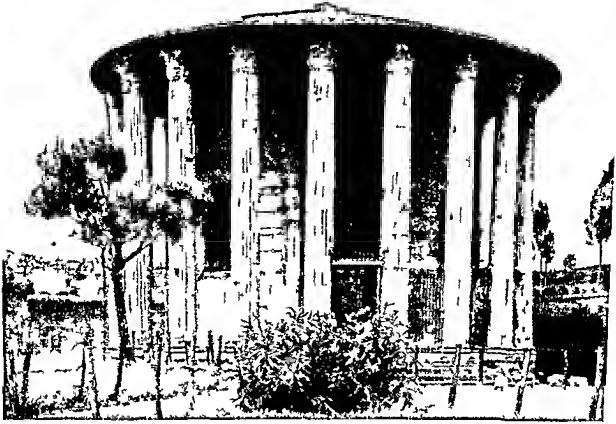
The Legacy of Greece

By 300 B C the development of Greek culture had been arrested, it was about to pass into other lands, and notably to Alexandria In the turbulent shifting stream of political vicissitude, Athens had sunk into a petty state, we witness, as Wells puts it, 'the swift rush of events that was to end for long ages these first brief freedoms of the human mind' Bury concludes his *History* with these words "The republics of Greece

* *The Legacy of Greece* edited by R W Livingstone (*Oxford University Press*)

THE ATRIUM OF THE VESTAL VIRGINS [*Mansell*

The state religions of ancient Rome centred round protective deities The *worship of* the virginal Diana was *of particular* concern to women Under her title of Vesta she was supposed to preside over the domestic hearth and it was the duty of her votresses the Vestal Virgins to keep the public and domestic fires burning Sir James Frazer, speaking of pre-Roman days says During her annual festival held on the thirteenth of August, at the hottest time of the year, her grove shone with a multitude of *torches* whose ruddy glare was reflected by the lake and throughout the length and breadth of Italy the day was kept with holy rites at every domestic hearth



[Man ll

THE SUPPOSED TEMPLE OF VESTA IN THE ROMAN FORUM

It was here that a fire was kept perpetually burning fed with sacred oak wood by the Vestal Virgins

had performed an imperishable work they had shown mankind many things and above all the most precious thing in the world fearless freedom of thought

* * *

The three centuries prior to the dawn of Christianity are centuries of transition here as in Hebrew history The culminating point of our story as regards the merging elements of Greek philosophy and Christian theology does not come until the first centuries of the Christian era We shall resume it from the religious standpoint beginning with the dawn of Christianity

Mithraism

One other and very important mystery religion—Mithraism—we have not mentioned in the above survey We shall refer to it later in a more convenient place At one time it would seem to have been the most serious rival to Christianity

§ 4

Ancient Rome

BUT before we leave the religions of the old world a short reference may be made to the religion of ancient Rome It must be very brief In the main but not in particulars it would be a repetition of the development of other primitive beliefs and practices In the days of the Republic we have to distinguish between the religion of the people of the country villages and the provinces and the State religion The natives in the country and provincial towns maintained the spirit worship of the old Roman husbandmen and the agricultural community worshipping the gods of nature of field and forest the protectors of their flocks the givers of harvest the gods also of family life who shielded the house and its inmates (Lares and Penates) This primitive form of religion is called animism it conceives the presence

Courtesy of the Manchester Art Gallery] [*Mansell*

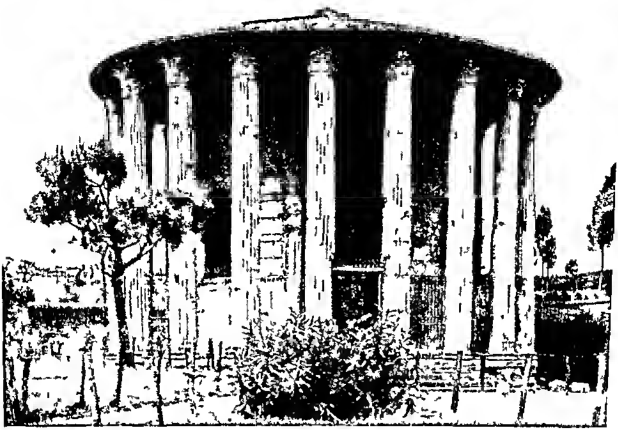
THE IDES OF MARCH

(After the painting by Sir Edward Poynter, R.A.)

The Ides of March fell on the fifteenth of the month. Even in the days of Julius Cæsar, prophecies of a soothsayer were taken heed of. On his way to the senate-house Cæsar was warned of peril by a soothsayer:

Cæsar: Who is it in the press that calls me? I hear a tongue, shriller than all music, cry "Cæsar." Speak, Cæsar is turned to hear.

Soothsayer: Beware the Ides of March.



[Mansell]

THE SUPPOSED TEMPLE OF VESTA IN THE ROMAN FORUM

It was here that a fire was kept perpetually burning fed with sacred oak wood by the Vestal Virgins

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Courtesy of the Manchester Art Gallery] [*Mansell*

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Soothsayer. Beware the Ides of March.

of spirits (*numina*), and not of developed or anthropomorphic gods Festivals were held marking the seasons of the agricultural year

The State religion centred round protective and tutelary deities like Jupiter, Mars, and many other gods and goddesses "We see," says Mr Cyril Bailey, "the gradual but unmistakable establishment of a State religion The old cults had been in the hands of individual households, the State now takes them over and consecrates them to its own uses A great temple is built on the Capitoline Hill—the centre of Rome—and in it is established the worship of a divine triad symbolising the religious majesty of the State

A priestly hierarchy too was created, *flamines* for the principal deities, and the college of *pontifices*, associated with many of the minor rites, presided over by the *pontifex maximus*, who becomes the repository of sacred law and keeps the secret of the festival calendar, which he only reveals to the people month by month" *

The State religion virtually tended to become *the worship of the State*, there was no priesthood, for the 'priests' were never a class apart, it was not a whole time vocation, the various religious offices were held by persons of rank, and politicians sought after them as positions of influence

Mr Bailey pictures how religious considerations began to govern the activities of the State and the great function of the State became clothed in religious significance first time is a real institutional religion with its sacerdotal organisation in the colleges of Pontiffs and Augurs here too is the definite linking of 'Church and State'—Greece shows *no* real parallel to it, and the Hebrew ideal of a theocracy is different from this partnership—and we can contemplate in its history both the value of the consecration of public life and the possibilities which it involves of the degradation of religion

The Roman from the earliest times was practically minded, and to some extent he was perhaps inclined to carry this into acts of worship, it was as it were a kind *of contractual* affair In return for his devotions he hoped that the gods would bestow their favours, so at least we might think Certainly the Romans lacked the warm and vivid imagination of the Greeks

Finally, when Rome came into direct contact with the Greeks, the educated classes began to assimilate Greek ideas, and the assimilation of foreign religious ideas had far reaching results in later history "Rome was thus prepared to receive, and the contact with Greece, which followed the conquest of Italy, opened the flood-gates As if conscious of her own lack of culture Rome welcomed with open arms what Greece had to give her Art, literature, philosophy, religion were eagerly accepted, and Rome set herself to imitate and adapt, and so in the end to create her own forms In religion the work was rapid and characteristic the old *numina* in the hands of the State had long been moving to a more concrete and anthropomorphic

[Drawing by Richard O[illegible]e

Salmon live and feed in the sea from the time they are about three years old, but when they are impelled by the instinctive desire to breed they enter the rivers and press steadily upwards, overcoming strong rapids and every obstacle they can possibly surmount in their search for a suitable spawning ground. Male salmon have been observed to leap waterfalls ten feet high.

Frontispiece

BOOK I—(*Continued from page* 218)

SCIENCE AND MODERN THOUGHT

CHAPTER VI—*Continued*

§ 1

MORE ABOUT INSTINCT

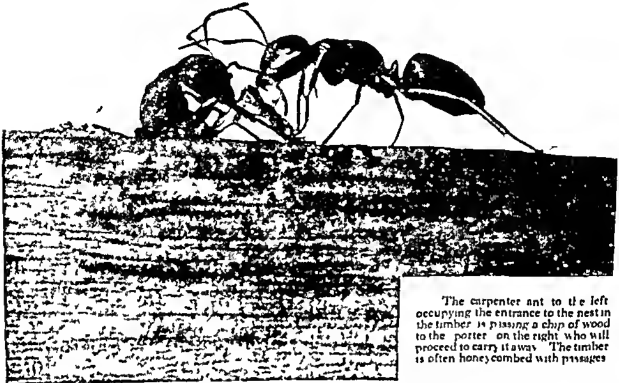
WE have spoken of Bees, as to Ants, Mr Lloyd Morgan, in his ***Animal Behaviour***, writes "In popular writings and lectures we frequently find some or all of the following activities of ant-life ascribed to instinct recognition of members of the same nest, powers of communication, keeping aphides for the sake of their sweet secretion, collection of aphis eggs in October, hatching them out in the nest, and taking them in the spring to the daisies, on which they feed, for pasture, slave-making and slave-keeping, which, in some cases, is so ancient a habit that the enslavers are unable even to feed themselves, keeping insects as beasts of burden, *e g* a kind of plant-bug to carry leaves, keeping beetles, etc, as domestic pets, habits of personal cleanliness, one ant giving another a brush up, and being brushed-up in return, habits of play and recreation, habits of burying the dead, the storage of grain and nipping the budding rootlet to prevent further germination, the habits described by Dr Lincecum, and to a large extent confirmed by Dr McCook, that Texan ants prepare a clearing around their nest, and six months later harvest the ant rice, a

[*Photo J J Ward*

THE GARDEN SPIDER'S WONDERFUL SNARE

The structure of the spider's web with its accurate geometrical arrangement of simple and compound threads forming respectively facility for the free movement of the spider and a perfect trap for the victim, is a remarkable instance of instinctive behaviour

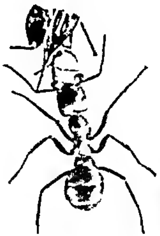
MARVELS OF INSECT ACTIVITY



The carpenter ant to the left occupying the entrance to the nest in the timber is passing a chip of wood to the "porter" on the right who will proceed to carry it away. The timber is often honeycombed with passages.

Photo: Paul Griswold Howes, Bruce Museum, Connecticut, U.S.A.

CARPENTER ANTS AT WORK (Much magnified)



[Photo W H Craxford

PART OF A COLONY OF SMALL GARDEN ANTS SHOWING PUPÆ WORKERS AND WINGED ANTS

The winged ants are the males and females The wings are used only in the nuptial flight when the pairing takes place Afterwards the males die but the females settle down shed their wings and become the mothers of a large family The workers are imperfect females

[Photo J J Ward

Ants shepherding greenfly or aphides whom they milk for their secretions of honeydew In some cases the ants take the eggs of the aphides underground in autumn and when the cows are hatched out the ants keep them in cattle pens of earth in the nest

Morgan says that expert opinion is divided as to whether there is any convincing evidence of any such ancestral memory

But the primitive creature, it would seem, must have become able to register its experience, and began to profit by what happened to it This capacity of registering experience, and of utilising that registration in subsequent activities appears to be of the very essence of life "We know as solidly as we know anything in physiology that the history of an organism does modify it and its activity—in ways not thoroughly understood doubtless, yet more than real *This is part of what is meant by organic memory'* Nothing is more distinctive of the organism than its compound interest enregistration " (Thomson)

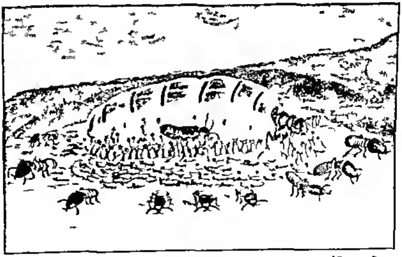
Instinct is the outcome of the creature s inborn constitution , as Lloyd Morgan defines it, instinct is "organic behaviour suffused with awareness,' or, as others state it, ' instinct is congenital behaviour "

The Basis of Instinct

The subject is a difficult and puzzling one , the general reader would not be much the wiser were

kind of grass of which they are particularly fond, even according to Linceceum seeking and sowing the grain which shall yield this harvest the collection by other ants of grass to manure the soil on which there subsequently grows a species of fungus upon which they feed , the military organisation of the ecitons of Central America , and so forth '*

All this we call instinct innate impulses leading to experiences that are registered in the creature's constitution But what the mechanism of the enregistration of the organic memory is we do not know , Lloyd



[James s Press

QUEEN TERMITE AND HER COURT

The Queen Termite is about the length of our middle finger Most of the length goes to the posterior body which is bloated with eggs The relatively small head and thorax are seen in front The Queen is lying in the royal chamber of the termitary the door of which although allowing her entrance is much too small to allow her exit now She often lays sixty eggs a minute and if she ceased to lay eggs she would be allowed to starve She is seen surrounded by a bodyguard of workers who continually feed her and outside there is a circle of soldiers

* *Animal Behaviour* By Lloyd Morgan (Arnold)

A BEAVER'S DAM [Photo New York Zoological Society

The storing instinct in animals is accompanied by knowledge of actual conditions How this knowledge is acquired is a mystery it is not the same kind of knowledge as our own Beavers construct dams across the stream or pond where they have made the lodge which contains their stores of food The object of the dam is to ensure that the water around the lodge will remain deep enough and will not freeze too deeply in winter time The dam is made of drift wood and willow branches cemented together with mud and stones

we to enter upon a detailed discussion of the physiological basis of instinct, that is to say, instinctive behaviour considered as an inborn predisposition of certain nerve cells and certain muscle cells, the predetermined paths in the nervous system laid down in the course of the creature's development and which has come to form part of the animal's hereditary constitution Neither would he be able to come to a conclusion were we to examine the views of those naturalists who stress a psychical side to instinctive behaviour, a psychical accompaniment on a low level There is no agreed conclusion to be stated

We have spoken of an organism registering experience , theories have been put forward that "the germ cells are supposed to treasure up some of the results of the organism's experience, as it were, by unconscious memory, so that when they come to develop they reproduce in some measure the traits which their parents or their ancestors acquired as the result of experience The idea is that the germ cells become stored with the latent 'memories' of past generations, or less metaphorically that the germ cells are changed or impressed in a definite and specific way by the organism's experiences Development is in part the 'recollection' of these germinally treasured 'memories'"

The present day views generally do not favour this theory, as against the theory of germinal variation changing the creature's structural organisation , on the neo Darwinian theory acquired characters are not transmitted Natural Selection, acting on germinal variations, has moulded the character of instinctive animals in a particular way and their behaviour is what it is because of that And there is no answer to the question Why ? except that it is a characteristic of evolution

THE THRUSH AT ITS ANVIL [Photo James's Press

Before the thrush can enjoy the palatable flesh of the snail it must first break the hard shell. This it does by picking up the snail with its beak and dashing it against a stone. Young thrushes, unsuccessful at their first attempts to do this, appear to "learn" the process, but it is probable a certain predisposition to break things on the ground is present.

§ 2

INTERESTING SPECULATIONS

As we ascend the animal scale of the evolutionary ladder it becomes difficult sometimes to draw any definite line between instinctive behaviour and intelligent behaviour. Intelligent behaviour implies that animals live and learn, "extending and improving on their original outfit, sometimes only slightly and sometimes very considerably, by personal adaptability and experience." Their intelligent behaviour is the outcome of consciousness; there are some psychologists, like Professor Lloyd Morgan, who believe that even instinctive acts are accompanied by consciousness which "marks them off from such reflex acts as are unconsciously performed, and from the tropisms of plants and other lowly organisms. There remains, however, the difficulty of finding any satisfactory criterion of the presence of consciousness."

Professor Lloyd Morgan regards instinctive behaviour as prior to individual experience, intelligent behaviour being the outcome and product of such experience. That is based, he says, on the facts of observation. At the same time acquired modifications of intelligent behaviour "presuppose congenital modes of response which are guided to finer issues."

In the absence of exact knowledge of the hereditary workings of a living being it is not possible to dogmatise on what is "behind" instinctive behaviour; no doubt as research proceeds a great deal that we are ignorant about now will become clearer. Modifications of a creature's behaviour in accordance with circumstances is said to be individually acquired, and, as Lloyd Morgan remarks, the profiting by that experience is the only criterion we possess of the existence of the conscious experience itself. Professor Lloyd Morgan expresses his conclusions in the following words

"We may say then that where these congenital modes of response take the form of instinctive behaviour there is supplied a general plan of action which intelligence particularises in such a manner as to produce accommodation to the conditions of existence We have already frankly admitted that in the present state of our knowledge we *do not know with any definiteness how intelligent* modification of behaviour is effected

Whether we approach the subject from psychology or physiology or the hereditary organisation of the nervous system we must agree that the nature of instinct is not to be explained by any laws of mechanism Let us consider this important point

In Wells and Huxley's *The Science of Life* we are told that the instincts of insects however extraordinary are for the most part nothing else but reflexes The *animal is* turned out complete with the possibility of playing a definite but limited repertory of tunes Its behaviour is part of its inheritance and just because *it* is so automatic no more demands thought than does our withdrawal of a pricked finger from a needle or the secretory activity of our pancreas when stimulated by secretin in the blood

Nevertheless the authors of that valuable work give very many pages to the study of instinct showing that it *does* demand thought — although in quite a different sense There is no thought about the instinctive act and it is just *that* fact which demands *our* thought Our authors say that the great variety of insect instincts are all variations on the same theme they are all behaviour which is in the main the rigid outcome of inherited nerve structure but *mechanism is no explanation* The instinctive mechanical act, at its first appearance was the result and in satisfaction *of* an inward drive and every advance in instinctive behaviour is the result of another drive If external circumstances change and if a purely instinctive creature is baffled in its attempts the drive may sometimes impel it to perform its business in a different manner And so the creature learns shall we say under this hypnotic drive (Methuen)

[Photo F W Bond

THE WONDERFUL NEST OF THE TRAP DOOR SPIDER

A long tubular shaft is sunk in the ground and lined with web material The opening is furnished with a neatly hinged lid its outer surface camouflaged to blend with the surrounding soil On the least hint of danger the spider claps to the door and scuttles down the tube Sometimes there are side tubes fitted with trap doors which enable the spider to escape in the event of an unexpected raid

Different ways of Knowing

In his book *Instinct and Experience* Professor Lloyd Morgan in an interesting chapter on The Philosophy of Instinct discusses the question Are there two different kinds of knowledge and two different ways of knowing ?

One kind of knowledge is that which human beings gain by conscious experience by experiment or by imitation by the intelligent adaptation of means to ends all the result of man's rational faculties Men are capable of forming

abstract conceptions, they have language to communicate ideas, and accumulating knowledge is passed on by one generation to another. Creatures below the level of man do not possess these powers, they have instinct by which it is meant it is not a principle of reason. However pure instinctive knowledge is gained, it is not acquired as human knowledge is gained. That is to say, it is not directly communicated by language, it is not acquired at first hand by direct observation and imitation of others, it is not arrived at by reasoning, or intelligent foresight. As we have seen in this book the most astonishing examples of instinctive knowledge is *that exhibited by creatures who "plan" for the* future without any kind of fore knowledge that such planning is essential, before the creature knows the event that is going to happen or what it is, it accommodates means to an end having no intelligent knowledge of what that end is, an end that is outside its own experience. Men plan for the future knowing what that future is likely to be; purely instinctive creatures come by their knowledge by quite a different way, where or how they get their knowledge we can only explain by saying it is "instinctive." Their knowledge comes from "within", it is innate and intuitive.

As Professor Lloyd Morgan remarks, "we have here the contrast between two different kinds of knowledge—two kinds which may indeed coexist in the same living creatures but which are essentially antithetical, or, at least, complementary in their nature—the knowledge that is innate and intuitive and the knowledge that is begotten of experience. And these two different kinds of knowledge are the expression of, or are due to, two diverse principles or faculties, the faculty of instinct and the faculty of reason."

Henri Bergson, to whom we have previously referred, regards instinct and intelligence as opposite and complementary kinds of knowledge, they represent two different and diverse expressions of divergent currents of evolution. Instinct is something immanent in the creature's constitution, almost infallible, but limited in its scope, intelligence, on the other hand, we regard as something exterior. The two powers immanent in life it may be surmised were originally intermingled as they still intermingle, although they have parted company in the evolutionary process they are not entirely divorced. Both have their advantage in life. Bergson has written on the subject with great precision. Some have imagined that his doctrine may be interpreted as giving instinct the advantage over intelligence, but that is quite a wrong view. In the case of instinct Bergson would say, "Knowledge is more felt, lived, and acted out, whilst in intelligence, knowledge is rather thought out and depicted. The field of instinct is its bearing upon *things*, of intelligence, its bearing upon *relations*." (Chevalier's *Henri Bergson*.)

Instinct and intelligence (says Lloyd Morgan) involve two radically different kinds of knowledge. If you ask "What *kind* of knowledge?" the reference must be to the *acted* knowledge of the bee and the ant and the bird, and in the case of intelligence to the knowledge that comes of conscious thought.

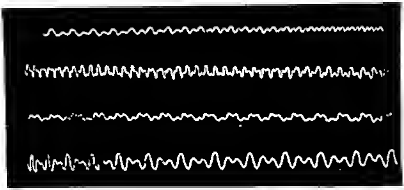
The reader will find a very thorough exposition and criticism of Bergson's theory in Lloyd Morgan's *Instinct and Experience*. It is Bergson who affirms that "intuition is instinct raised to its highest power." But that is taking us into the realm of philosophy. The problems of Intuition and Instinct are not yet solved by Science to our satisfaction.

The Problem Unsolved

If one holds any philosophical view about instinct, then, as usual with philosophies, it is capable of neither proof nor disproof. The ordinary man—and perhaps in that he is not unlike the expert—will tend to that view which accords with his own temperamental constitution, or philosophy of life, and his particular views regarding the universe itself. It is hard to dislodge any philosopher from his standpoint, "each squints and overlooks half the facts and half the difficulties in its eagerness to find in some detail the key to the whole."

CHAPTER VII
THE PROBLEM OF ETHER AND "SPACE"

IN a previous chapter in Book I we briefly referred to the achievements of modern physicists in changing our views about the nature of the physical universe, the subject is explained in detail in Book II There is one other aspect of physical science we have not touched upon and it is one of peculiar interest to the lay reader The nature of the Ether and "Space" is another unsolved problem The concepts of Relativity theory are difficult, and the subject does not lend itself to a short summary Relativity theory, therefore, will be explained in a later chapter, where it will be dealt with as a whole Meantime, in a general way, let us see how our views about the Ether and Space have been altered



WAVE SHAPES

In all radiations various forms of wave motion arise from electro magnetic vibration Light visible and invisible light radiant heat and electromagnetic waves are all of the same nature but differ greatly in length and shape Radiation may be regarded as electro magnetic vibrations *or* ether waves

The nature of light is a problem that is still unsolved Does the ether exist? There is the authority of Eddington for saying that among leading scientists to day about half assert that the ether exists and the other half that it does not This statement is not so startling as it sounds It means really that the two parties have different notions about what used to be called the ether, but there is little to divide them but the use of the word Where one party speaks of 'ether" the other would say "space' Let us illustrate by describing what the two views are

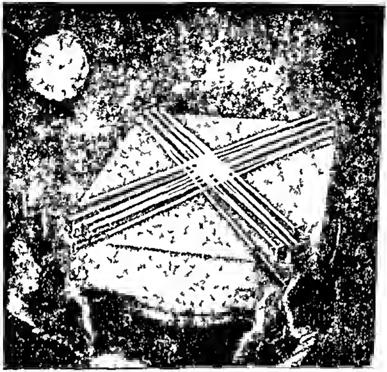
Every one is more or less familiar with the notion of an 'ether" Everywhere we find references to this vast medium, supposed to fill all space, and which transmits light, radiant heat, and the waves of wireless telegraphy It was conceived as a sort of jelly or "elastic fluid" The vibrations of this jelly constituted light The evidence in favour of the existence of the ether seemed to be overwhelming We know that light is a wave-motion and that it takes time to travel It takes about eight minutes for light to travel from the sun to our earth In what form does light exist in the intervening space? If it is a wave motion it must be a wave motion of something We cannot imagine waves without something that is waving That something is what we call the ether It is this same ether, it is conceived, that conveys wireless waves, and, indeed, any form of radiant energy It permeates the interstices of solid matter Evidently it is everywhere

How then, does it come about that many modern scientific men deny the existence of the ether? In the nineteenth century scientific men had hopes of explaining everything by the ether Not only radiant energy, but matter itself, was to be reduced to an etheric manifestation Why have these hopes been given up? How is it that this great concept has now become so unfashionable? It is because we can get no direct evidence of the existence of the ether Every experiment designed to reveal the presence of the ether has been a failure No experiments —and there have been extremely clever and elaborate experiments like the famous Michelson-Morley experiment—have ever detected the existence of the old time ether, and attempts to work out its properties have been given up

"How much does ether weigh? Is it lighter than hydrogen or denser than platinum? Is it fluid like water or rigid like steel? How fast is our earth moving through it? In which direction do the particles of ether oscillate when a wave passes over them? These are some of the questions one naturally asks, and at the end of a century's study, physics can give no answer to any of them" (Eddington) Ether has no weight, and is not a kind of matter, it is non material Sir James Jeans says that nature acts as if no such thing existed

An alternative theory about ether

What, then, is the alternative? Einstein was responsible for the abandonment of efforts to prove the existence of the ether He showed that no such motion ever could be discovered, he did not disprove the existence of the ether He simply ignored it in his new and revolutionary conceptions of space and time *It is "space" that now comes into the picture* We must turn to the ideas of those who speak of the ether as "space" Once more, we must turn our old notions inside out We must not think of space as a sort of "passive emptiness" We must change our notions of space Space *is an active agent*, or so it seems, "it is as much a performer in the world drama as matter is" That, says Eddington, "is the gist of the ether theory, whether you care to use the word ether or not I think the plain man will hardly attain this picture if he conceives nothing but empty space outside matter Some essence or quality capable of modification and *activity must be added to the ordinary conception of space, and it is this addition which we try to convey when we say that all space is filled with ether*"



AN EXPERIMENT THAT FAILED

There is no proof of the actual existence of ether As Sir James Jeans says Nature acts as though no such thing existed Michelson and Morley in 1887 arranged a number of mirrors on a solid table floating on a circular bath of mercury A lamp threw a ray of light which was divided by partial reflection at a thinly silvered surface into two parts running at right angles to one another Their theory was that the stream of light passing in the direction of the assumed flow of ether would travel at a different rate from the stream of light passing against or across it

In this way they hoped to test the velocity of the earth relative to the flow of the ether To their surprise no difference was observable Einstein has since shown that there is no way of detecting the existence of ether

The properties of space

We shall come later to consider what physicists conceive to be the properties of space, when used as another name for ether. We shall hear about ether-waves, but we must not imagine them to be wavy undulating movements or vibrations in all pervading ether We must *not* liken them to the rippling wavelets that follow the splashing of a stone into a still lake We may still think of wave-movements in the ether, but what the physicists want us to picture is space—the "empty" space stretching out to the distant starry heavens and far beyond—as *full of radiations of an electromagnetic nature* Not only that space, but the roomy space there is between the electrons in the infinitesimally small atom You may call this space or you may call it ether

The radiations are there, spreading out in every direction, and in their nature electric That is some idea of what is called space Space is filled with the radiated energy of bodies, a part of which we call light

Ether and space

Einstein, we have remarked, gave up the assumption that the ether exists when he published his theory of relativity He found that he could get on perfectly well without the ether, and that he certainly could not get on with it Einstein's space can be referred to as an ether, if one wishes to preserve the word ether This is the way in which Eddington uses the word, for example But this ether has almost nothing in common with the old ether It is not in the least like a gigantic jelly filling up space It is just space, but space of a very complicated kind, and it is capable of undergoing some kind of wave oscillation

We shall have to return to that when we come to consider the relativity theory Meanwhile, to give the reader a hint as to the properties of space (or ether) we quote the following passage, written by Eddington for the *B B C Yearbook* (1930)

"The mathematician describes the state of the ether by symbols, and he describes its characteristic properties by mathematical laws which the symbols obey When one of the symbols takes rapidly fluctuating values (positive and negative), that means that a wave is passing over the corresponding spot in the ether, the period of the fluctuation indicates whether it is a radio wave, or a light-wave, or an X ray The same symbol taking a steady value will indicate a magnetic or an electric strain in the region And so the symbols serve to connect up phenomena which at first sight appear totally different It is all very mysterious—using symbols without having the least conception what they really stand for, but that is the way we are able to extend science into regions beyond reach of any of our familiar conceptions I need scarcely remind the listener to broadcasting that these methods have abundantly justified themselves by their practical results"

He adds that the ether is more fundamental than matter—"a simple basis out of which matter emerges as a complex structure"

Two theories

As to how light is propagated we must refer the reader to what will be said in discussing the quantum theory (*See* page 285) The question is not yet decided It will be remembered that we said the old wave theory explains a good deal But there are very important recently discovered phenomena that it does not explain at all There is a theory, the "quantum theory," that explains these phenomena, but the quantum theory does not explain the phenomena the old wave theory explains

At present physicists use both theories, and the great task at the moment is to work out a theory that shall include both the corpuscular and the wave theory

It would interrupt our present story too much to enter into a description of all the various kinds of light rays We shall see that the actual nature of light is not yet definitely known Light, visible and invisible light, radiant heat, and electromagnetic waves are all of the same nature They differ only as regards their wave lengths For the present we regard radiation as electromagnetic vibrations or as ether waves of diverse wave lengths Radiations may start in sun and star as explained in the chapter on astronomy, and they may originate inside terrestrial atoms in the way we shall presently explain

(*For continuation of this subject turn to page 285, Book II*)

[Photo: A. C. Banfield

" Men call me cruel: can I tell
If goat or reed-buck feels?
I only know they make me light
And salutary meals."

CHAPTER VIII
THE SYSTEM OF ANIMATE NATURE

§ 1

Is Nature Cruel?

We have tried to explain in the previous chapter the conclusions of biologists and naturalists on the problem of instinct. The problem has not been solved. It cannot be conclusively solved until science gets more knowledge. It will not be out of place if we now turn from our discussion of the evolution of mind and instinct to the drama of life itself as we see it in animate nature. We shall not import philosophical reflections; what conclusions are to be drawn will appear as we go on. Philosophy took a great stride when men first began an intensive inquiry into the system of Nature, animate and inanimate. The more science investigates and surveys and evaluates the phenomena of the objective universe, the more data are placed at the disposal of the philosopher. Apart from any question of philosophy, the benefits to mankind resulting from the study of a world in which we live and an understanding of Man's place in the scheme of Nature are too obvious to dwell upon.

What may we believe about what naturalists call the system of animate nature? What can we read into it, if anything—the phenomena of animate nature as we see it as a whole in the daily life of bird and beast and every wild creature. In his poem *The Tiger* William Blake, contemplating that particular wild beast, asks the

[Courtesy of Messrs T. Nelson & Sons Ltd.

WOLVES DEVOURING THEIR PREY

The scientific attitude towards "Nature red in tooth and claw" is fully discussed in this chapter. What seems "cruelty" in nature is only one side of the struggle for existence, as we shall see.

question "Did He who made the lamb make thee?"

> Tiger, tiger, burning bright
> *In the forests of the night,*
> What immortal hand or eye
> Dare frame thy fearful symmetry?

In animate nature there is intermingled beauty and goodness with the ugly and the cruel We must take account of both

What we aim at in the following pages is a sort of all round or synoptic view of the response and reaction of various creatures to their environment and to the primal facts which govern their being We are not proposing any strictly biological analysis, laying aside analysis, we are merely picturing the characteristics of living creatures when we look at them in an all round impressionist way In other words, let us see the daily life of bird and beast in action, disregarding evolutionary theories of the "why" and the "wherefore" of this and that

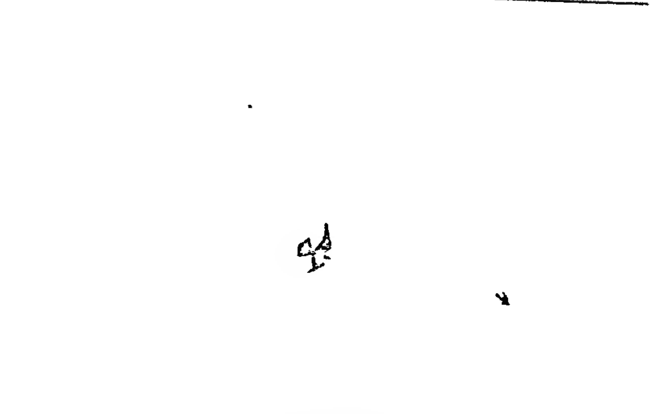
Here we confine our attention to some aspects of animal life as we see them before our eyes every day The grim fact of the Struggle for Existence among all creatures is too obvious to need any demonstration as a broad fact More than that, it is sometimes so subtle as to escape the notice of all but the trained naturalist, and the observant biologist's investigation

It is quite wrong, however, to regard the Struggle for Existence as conducted wholly on a life and death competitive basis That is a wrong view point That is only one side of life, for there is also a co operative regime in which we see the "struggle" in a somewhat different aspect a struggle for the wellbeing of race, rather than for individual existence We shall not, for the moment, go into the reasons for the struggle for existence, first of all let us just survey the observable facts of animal life

[Photo Eric J Hosking

The fishing cat seems to radiate hate in a way no human features could

If beast, bird, and man would live they must eat, and to eat, the life of some living thing must be given up. To satisfy the primal impulse of hunger is a matter of self-preservation And in satisfaction of this, and other primal impulses of its being towards race continuance, what crimes, robbery, and murder are committed by bird and beast in the struggle for existence! We say crimes, robbery, and murder, but, of course, we use the words in a sense that does not imply moral responsibility as in the case of a human being The poet Tennyson wrote of "Nature red in tooth and claw", this sanguinary phrase pictures it quite unfairly, it is



WAR IN MID AIR (Photo: Capt. C. W. R. Knight

A female Merlin in hot pursuit of a Carrion Crow. This small hawk-like bird is an extremely fast flier and a most persistent hunter. She can keep in the air a long while making successive swoops until her victim is exhausted and unable to manœuvre at the psychological moment. The Merlin catches her prey by seizing it by the neck in one foot that has a powerful grip, and kills it almost immediately with a few swift bites

but one side of a picture. The struggle has a larger meaning; significant facts lie behind it. It is a normal state of animal life. In ordinary language when we speak about cruelty we have in mind a definite disposition that is indifferent to the inflicting of pain and suffering; at its worst delighting in it. There is "cruelty" in Nature, but it is not the cruelty to which we attach that moral responsibility. The view one takes of cruelty in Nature depends on what interpretation one may choose to put upon Nature herself, in other words, on one's philosophic views. The scientific mind regards "cruelty" in the animal world from the point of view that it involves the plan or scheme of nature and evolution.

If we disassociate the struggle for existence and its attendant "cruelty" from other aspects of animal life, if we look at it in the raw, as we look at ruthless human war, we experience moments when the cruelty of it strikes home to the humane heart.

Enjoying a stroll in the quiet eventide you chance to look up to see against the pale blue sky a couple of wild ducks speeding through the air with unusual haste; by and by you see, overtaking them with the rapidity of an aeroplane, a peregrine falcon, the lord of the hawk tribe. You stand and watch—to see the gap between pursued and pursuer gradually lessen; with a cry of terror the ducks swerve, swift as a bolt from the blue the peregrine descends, and as swiftly his victim is in the grip of those terrible talons—forced down and down to the ground, done to death and devoured on the spot. Why should it be? you ask yourself, and perhaps you are answered by an agonised squeal that smites your ears. The blood-thirsty weasel in the hedgerow has closed his relentless jaws on his squirming victim and is now sucking the very life blood from its writhing body. Daily, far from the haunts of man, there are such unseen and unrecorded tragedies by the hundred; sudden

[Reproduced by courtesy of Messrs. Methuen & Co. from "A History of Birds" by W. P. Pycraft. (After a drawing by G. E. Lodge.)]

PEREGRINE FALCON ATTACKING A ROOK

The Peregrine Falcon, which has been described as "the most powerful bird for its bulk that flies," preys largely on other birds, which it attacks during flight. The Falcon's aim is always to get higher than its quarry; it then "stoops" from above, killing not by force of impact but by the grip of its strong talons.

[To face page 2,6

enormous gape at full extent and the great pouch below its beak ready to receive what comes And the cunningness of a party of them, working in concert, sweeping the pool in a long line like a living seine net Wholesale sudden death

The Kingfisher, that lovely, brilliantly coloured bird which most of us have seen and admired much, frequents streams and rivers, day after day returning to the same perch, to sit there, silent and still, to wait the moment to play the part of an assassin Darting into the water, it emerges with its victim—a victim to be beaten to death against a branch or a stone and swallowed whole, head foremost

Somewhere else, on a fine summer day, perchance you may see the Butcher Bird (Red backed Shrike) at work practising his devilish methods This bird has won its unenviable name of butcher bird from its habit of impaling and hanging its victims on the thorns of a bush or hedge as on a butcher s stall

From its perch it watches for its prey, but is by no means a motionless and depressed looking watcher its movements on its stand as it turns its head from side to side and jerks and fans its tail frequently uttering its low, percussive, chat like chirp or call note, give the impression of a creature keenly alive to everything passing around it The butcher bird is, in fact, attentively watching air, earth, and the surrounding herbage and bushes for a victim which he captures by a sudden dart, taking it by surprise He often devours his captured victims on the spot, then returns to his stand, but he has also a favourite thorn bush or tree to which he is accustomed to convey many of the creatures he takes, to impale them on thorns or fix them on forked twigs" There these victims, impaled on the sharp thorns of bush or hedge, remain till the butcher, with his sharply hooked, toothed, rapacious beak, is pleased to dismember them at leisure, taking out the choice bits This is the fate of many a small bird, such as the great tit, the blue tit the robin and hedge-sparrow young blackbirds and thrushes

THE BUTCHER BIRD

H s name describes his evil habits He often devours his captured victims on the spot then returns to his stand but he has also a favourite thorn bush or tree to which he is accustomed *to convey* many of the creatures he takes (insects and *small b rds*) *to impale* them on thorns or fix them on forked twigs

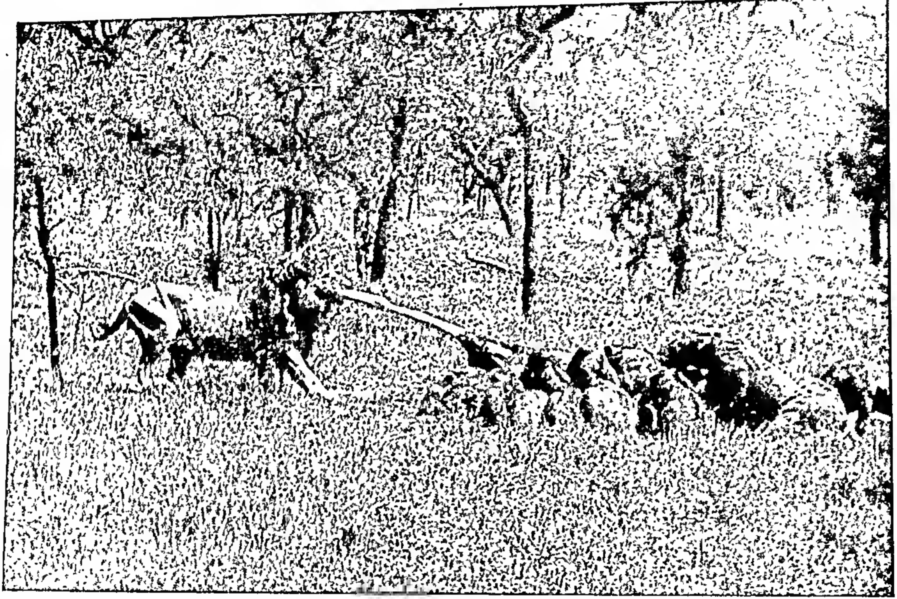
Somewhere else there are Black backed Gulls, which Mr Mortimer Batten describes as the pirates of the glen They sit about the lochs and watch the wild ducks As pictured by Mr Batten they will sit on the surface waiting till they see a mother duck lead her brood *forth* from the rushes, then wheeling and swooping they will pick

FLASHLIGHTS IN THE JUNGLE

[Photo. F W Champion

LEOPARD AND KILL A TRIUMPH OF FLASH-LIGHT PHOTOGRAPHY IN THE INDIAN JUNGLE

HYENA ON THE PROWL [Photo: F. A Jones



THE STRENGTH OF A LION

The above photograph was taken in Tanganyika Territory by Captain Murray Smith, the well-known East African big-game hunter, who explains the incident as follows: "At first the old lion remained patiently looking on while his lioness and cubs were feeding on the 'kill' (in this case a wildebeeste). Presently, however, he began to feel hungry himself and grew tired of waiting for his family to finish their repast. So he walked in, and, despite their expostulations, seized what was left, while they offered a strenuous resistance. He is seen dragging along one full-grown lioness and at least ten cubs of all sizes—showing his strength."

[Photo Dr Francis Ward F Z S

NATURE RED IN TOOTH AND CLAW

The sudden deep dive of this otter has meant the end of an innocent trout's existence Otters are roving hunters to whom all is grist that comes to their mill Usually however a wild duck or some large fish loses its life to satisfy the otter's voracious appetite

up the ducklings one by one, dropping each in turn to the water in order to kill it, where after it is swallowed whole Also they will tear to bits and devour any weaker bird they can catch" Must we call all this cruelty, or must we make a deeper study of Animate Nature to find some kind of understanding? Before we begin to inquire into that let us see something more of 'Nature red in tooth and claw'

It is not far to seek It goes on in earth and air and sea, in forest and jungle river and glen and mountain top, before our observant eyes as much as in solitary silent places where there is no man to witness it As dusk fades to darkness the stoat the badger, the otter, and the fox leave their dens The stoat on its murderous expedition is stealing upon the unsuspecting grouse In the silent watches of the night the wandering tireless otter, 'the Bedouin of the wild by some quiet moonlit stream or riverside has its struggling prey in its tenacious grip perchance a wild duck awakened from its slumber by the lakeside Reynard the Fox on the warpath, is stalking the mountain hare, in the still night an agonised shriek tells the death sentence of a rabbit Has Reynard any notion of cruelty as he stealthily makes his way to rob a hen roost? Whatever the innocent chickens or ducklings may feel the fox is merciless, more than merciless is this "nightly robber of the fold" for he sometimes runs amok and kills more lambs than he can possibly use His artful tricks to deceive are the last word in cunningness He will sometimes gambol in an extraordinary manner (chasing his own

[Photo A Mortimer Batten

A MIGHTY HUNTER

Foremost in blood fury the gluttonous weasel when excited by the sight of booty often seems to kill for the sake of killing It is at least as courageous as it is destructive it will attack animals many times its size and sometimes when seized by a hawk it will turn the tables on its captor by giving it a fatal bite in mid-air

tail for instance) in the presence of rabbits who stand by like interested and amazed spectators until the seeming entertaining clown suddenly makes a snap at a throat and the comedy ends in tragedy

The stoats will play the same unholy, cunning trick Sir J Arthur Thomson gives the following personal experience on an Aberdeenshire golf links As we were approaching a putting green we saw a circle of small birds including larks and meadow pipits quite still on the grass We wondered why they were so quiet so we approached very slowly and then we saw a strange sight In the middle of the gallery of birds there were two young stoats behaving in an extraordinary way They were jumping into the air and turning somersaults they were gambolling they seemed to us to be making living wheels' of themselves The little birds were standing as if spellbound preoccupied with the strange behaviour of the stoats We should not use the word fascinated,' but there may have been some deep seated dread beneath what looked like amazed interest But we had to go on and at the first movement forwards the stage was empty—birds and stoats had vanished We know however that if we had been able to make ourselves invisible there would soon have been two birds missing and two stoats well pleased For it is a device that stoats sometimes employ in catching birds It is like turning play to a use The birds are preoccupied—we came quite near them—and their interest is their undoing Two quick jumps and two birds are instantaneously dead It is all so quick that it is sheer nonsense to speak of cruelty Every creature must die some time

True enough they must but can we banish the notion of cruelty during those terrible minutes when two lions get the better of an antelope or

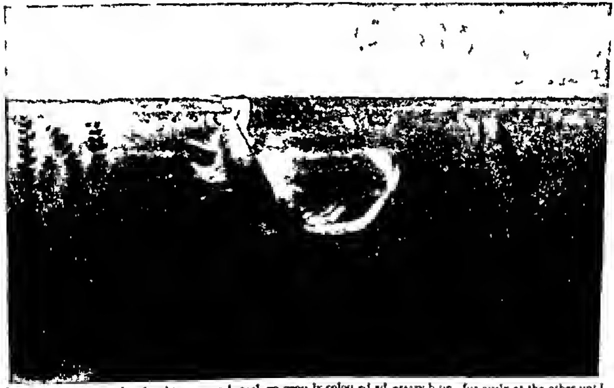
[Photo Herbert G Ponting F R G S

SKUA GULL IN THE ACT OF STEALING PENGUINS EGGS

The Skua gull is a heartless robber filching eggs from the nest of the quiet living penguin It is all done in a second a swift pounce a flurry of wings and the gull with its powerfully hooked bill has his meal at the expense of the helpless penguins whose frantic despair is clearly shown in the picture

SIAMESE FIGHTING-FISH IN BATTLE ARRAY

It is perhaps less natural for creatures to fight for the sake of fighting than it is for human beings. Most fish either devour other fish at a gulp or ignore them. The tiny Siamese Fighting-fish—it is only three inches long—is pugnacious by instinct. Normally it is drab and inconspicuous in appearance, but nature has provided it with a special device enabling it to strike terror into its foe, or so we might think. When in fighting mood it can inflate its branchial membrane a deep claret red. The combatants are seen approaching each other with gills widely extended and fins unfolded.



The duel once started is fought to an end, each gorgeously coloured adversary biting furiously at the other until the fins are tattered and one or the other is incapacitated or killed.

Photo [illegible]

[Photo Frances Pitt

REYNARD ON THE PROWL

The fox is a merciless stalker of weaker creatures the sheep fold the hen roost and the rabbit warren are to him natural quarries And he is greedy He has been known to snap off the heads of fifteen fowls at a swoop

the wolves close in upon the deer huntsmen like Selous have spoken of the frenzy of fear and agony of a dying brute ' Only intrepid sportsmen and naturalists get a glimpse of this side of fierce savage life among the wild beasts mostly in regions difficult of access The remote forests, mountain recesses the prairies, and the wild places of Africa Asia and America are scenes of stealthy stalking of one wild beast by another—of ferocious, prolonged sanguinary combats death-dealing blows and lacerating wounds, rending flesh and agonising cries The shadow of what Huxley called 'the huge gladiatorial show' Sometimes, too, there is an occurrence of what looks like sheer devilry " The Leopard hunting down the Spotted Deer, the bloodthirsty Lynx killing for killing's sake, the Tiger tearing its prey from limb to limb, the Lion and Hyena plunging their bleeding teeth into the flesh of their victims, the Cheetah overhauling the Blackbuck to knock it off its feet and pin it by the throat, the red dripping jaws of the hungry Wolf, the Polar Bear daring in its attack on the Walrus, the ' Grizzly " with its terrible forepaws rending the ribs from a Bullock's spine, with a leap the Wild cat descends on the back of a Swan and his jaws close with a crunch on the swan s neck These are things we may not have all seen, but they are the words of eye witnesses

Nature has made the animal and Nature has evolved, too, and provided the most deadly weapons for one animal to fight another The naturalist calls them ' adaptions ' We are not thinking of fearsome teeth and claws and hoofs which are bad enough, but of specialised weapons Think of the Sword fish with its long, pointed sword like prolongation of the upper jaw with which it can transfix a Tunny or even a Porpoise (It has been known to send its sword accidentally through the two inch plank of a vessel) The Walrus has in its upper jaw two long canine teeth or tusks (which may reach a length of three feet) and these formidable weapons enable the walrus to strike downwards sideways, and even upwards quickly and effectively Even the Polar Bear which is the only animal strong enough to attack him has to be very wary, for

[Photo Captain C W R Knight F.R.P.S

The nest of the carrion crow affords grim evidence of its ruthless and ind scrim n te habits It is ma nly composed of the skeletons of b rds and small mammals

if the walrus succeeds in pinning him down he will hold him under water until he is drowned

What bird has a chance against a weapon like the bill of the falcon, or little fishes from the puffin's bill, so well adapted for catching them and carrying them off to its own nest, or what escape is there from the pelican's weapon? The game-birds have long, pointed spurs upon the legs which are powerful weapons, as some birds with stout beaks may beat out an opponent's brains, so can others with their powerful spurs do deadly hurt We need not multiply instances or particularise further, what we have pictured is what the poet calls Nature red in tooth and claw '

[Photo Frances Pitt

PUFFIN WITH FIVE FISHES

What chance have small fishes to escape the Puffin's bill so well adapted for catching them ?

And what does it mean but that an animal must find its food if it is to live ? One species of beast and bird must kill numbers of other species in order to get a living It is a law of their being If man has to kill beast and bird to satisfy his hunger, it is no murder for the stoat to relentlessly hunt and kill the rabbit, or the badger, the otter, or the fox to hunt its prey, it is no more bloodthirsty for the black-backed gull to seize a duckling than for the blackbird to greedily pick up innocent worms on the dewy lawn

All this killing and dying is an assurance of continued existence of generations of animals and human beings alike It is *natural*, a trite thing to say, but all that can be said

But let us pass from this to note the behaviour of the members of one species towards each other

All this we have been describing is but the detail of a larger picture of nature, which if we would see it truly we must see as a whole We cannot leave the subject of the ' struggle ' we have been speaking about without a reference to another and gentler side of it, which is one of the great wonders of Nature

(*To be continued on page* 325)

BOOK II—(*Continued from page 242*).

MODERN SCIENCE

CHAPTER VI—*Continued*

THE NATURE OF THE MATERIAL UNIVERSE

THE ROMANCE OF MODERN PHYSICS (*continued*)

§ 1

THE PRINCIPLE OF INDETERMINACY OR "FREE-WILL"

THE quantum theory absorbs the interest of men of science more than anything else does. It is one of the most celebrated and important theories in modern science.

One thing has emerged from the quantum theory which has given rise to much discussion, and is revolutionary in scientific thought. Hitherto the doctrine of strict causality in the material world held the field. All physical phenomena, it was believed, rested ultimately on a scheme of completely deterministic laws.

E. N. A.

MAX PLANCK

He is the author of the Quantum Theory which has raised the idea of "free will" in nature as opposed to strict causality in the material world. This interesting question is dealt with in the text. His brilliant achievements will always be associated with those of Einstein, Rutherford and Bohr in connection with the development of atomic theory.

All the indications are that strict causality has dropped out permanently" (Eddington). There is no cause to be found that accounts for every occurrence. That would be a revolutionary admission on the part of science, and one of great philosophical significance, if physicists were unanimous on the point.

To fully understand what has come to be known as the "principle of indeterminacy" (or free will, if you like) requires deeper knowledge of mathematical physics and the wave-theory of matter than we have ventured upon in dealing with the quantum theory. The equations of the mathematician, and mathematical reasoning, can only be understood by a mathematician.

There was supposed to be unbroken continuity; we might not know all the laws of cause and effect, but such a universal law of cause and effect was presumed. It got a rude shock in 1927. In that year physicists saw "strict causality abandoned in the material world.

An accurate and technical description of the scientific grounds on which indeterminacy in nature is argued would be over the head of the average reader. For the moment we shall post

pone that, let us first try to get a general and broad view of the point at issue What is known as The Law of Causality was unanimously accepted until quite recent years as a fundamental principle in scientific research The question now is whether the doctrine so held, namely, that every event in nature proceeds from another event which is called the cause, must be abandoned. Is strict causality no longer a tenable belief? Has it to be admitted that there is something like freedom at the basis of natural processes, that is to say, at the foundation of atomic phenomena, and does this lend support to the doctrine of freedom of the human will?

It has to be *said at once that scientific* men *are* of two minds about the conclusions to be drawn from certain admitted atomic phenomena To contrast the two bodies of opinion let us first take Sir Arthur Eddington's views He is one of the *chief*, *and* m*ost* emphatic, exponents of the conviction that the law of causality has broken down and must be abandoned Let us see what his conclusions are, leaving aside, for the moment, the scientific evidence We have already quoted him as saying that 'all the indications are that strict causality has dropped out permanently" Other eminent physicists have expressed a similar view He speaks of this as one of the most revolutionary changes of scientific thought in the present century "The conclusion can be stated simply The result of our analysis of physical phenomena up to the present is that we have nowhere found any evidence of the existence of deterministic law' *

Now let us turn to Professor Einstein He admits *the impossibility of maintaining* causal sequence in the inner processes of atomic physics in the present state of knowledge, in the ultimate elements of the physical world it cannot be shown that the Law of Causality holds good, *it* would *seem* as if it did not As Professor Lindemann puts it, causal law' fails completely when applied rigidly to the behaviour of the ultimate particles of which reality is composed' Einstein does not dispute the evidence that in quantum phenomena the behaviour of the electron is not determined But, unlike Eddington, he does not think that determinacy has gone for good; *he holds that with more knowledge the time will* come when deterministic law will ultimately have to be reintroduced in physics Max Planck, the author of the quantum theory, holds the same opinion

In a recent interview, to the statement that "it is now the fashion in physical science to attribute something like free will even to the routine processes of inorganic nature," Einstein replied "That nonsense is not merely nonsense It is objectionable nonsense" Interviewer "Well, of course, the scientists give it the name *of indeterminism*" Einstein '*Indeterminism* is quite an illogical concept What do they mean by indeterminism?" Then he launches into complex technical definitions, etc, etc, which we cannot summarise, since we are trying to keep to the *broad*, *simple question at issue* without cumbering it with technical detail Discussions of determinism and indeterminism can, as Eddington says, like many other discussions, be confused by questions of definition

Such then are the views of two eminent scientists on this all important subject, and they represent the views of two schools of opinion among leading physicists, both equally definite and emphatic in stating their case

Now we may say a few words about the development in atomic physics that led to the abandonment of strict causality in the material world We shall speak of it as that, since we have given both sides of the question. It is the most far reaching principle that has yet emerged from the Quantum Theory It began with the theory that the behaviour of the electron is not determined, it has "equally probable' choices of behaviour, as the physicists express it

§ 2

TO repeat our starting point was the atom, the hard sphere out of which molecular and physical materials are built up, then we saw these atoms were wholly composed of units of electricity, electrons and protons, then we arrived at the quanta, 'atoms of energy' It is

* *Journal of Philosophy*, January 1933

meaningless to ask 'what is electricity?' for it is a fundamental reality, and that is all that can be said

Next we explained the interaction of quanta and electrons and that an impact of the quantum can start an electron in motion The behaviour of the electron in these circumstances does not seem to be determined, there seems no 'cause' why it should choose one path rather than another In one experiment it will choose one path, in a repetition of the experiment repeated under identical conditions it will choose the other path, it cannot be predicted that it will reach a position B from a position A In other words 'its future conduct is not uniquely determined by its present state'

We have said that physicists have no knowledge of the existence of an atom *except when it is* radiating energy, no physical apparatus can detect an atom when it is not radiating energy An atom only reveals its existence by interacting with the physical universe, and these interactions are always accompanied by energy changes that is, with the movements of the electrons

Let us be clear about what is called the principle of indeterminacy Let us reflect, first of all, that we can only know of the existence of something by the reaction of that something on the external universe Anything that was *completely* isolated, whether it be an electron or a star, would be completely unknowable *For its existence to be detectable* it must interact with the external world (if we want to see it, for instance, it must send light to us) and every such interaction involves an interchange of energy But this interchange of energy reacts on the thing we are observing *It is no* longer behaving in the same way For the ordinary bits of matter that we are concerned with in science this *reaction* is too slight to be observed It makes no practical difference

(Photo Gillman & Co

DR ERWIN SCHRÖDINGER

One of the leading mathematical physicists of to day he holds that the ultimate happenings in the physical universe are not pre destined the present and the future are not uniquely determined by the past Dr Schrödinger was born at Wien in 1887 He was awarded the Nobel Prize for Physics in 1933

But the matter is very different when we come to single electrons Here the minimum possible amount of energy, just one quantum, is sufficient to disturb the electron Any method of observing the electron affects the circumstances of that electron and renders its future *uncertain* By merely 'observing' the electron we alter its behaviour, and we alter its behaviour in an unpredictable way If we make an exact determination of the position of an electron, for instance, we do, by merely making that observation, disturb the velocity of the electron in an unpredictable way All our measure-

ments are attended by a margin of uncertainty. If we make one measurement more precise, we necessarily make another measurement less precise. The more accurately we know the position of an electron the less accurately we know its velocity. Now we have to know *both* things exactly in order to say exactly what the future motion of an electron will be. And as we *cannot* know both things exactly, we cannot make any exact predictions. Thus the fundamental processes of nature must be treated by us as *indeterminate*. The strict sequence of cause and effect hitherto assumed in science is found to be no longer applicable.

It is this fact that has led some scientific men to assert that something like free will must be assumed to lie at the basis of natural phenomena. Other scientific men, as we have said, such as Einstein and Planck, do not believe that this conclusion is necessary. So that the layman would probably do well to regard the question as an open one at present. In any case, the free will in question does not affect the fact that laws of nature exist. The planets will continue to go round the sun, and stones, when dropped, will continue to fall to the earth. But if the free will theory be admitted all these scientific laws acquire a different status. They all become merely statistical laws. That is, they apply only to huge collections of electrons, such as we deal with in any ordinary sample of matter. And they can be successfully applied to such huge collections only because the individual free will motions of the separate electrons cancel out, as it were. The life insurance actuary knows of no law which says that any individual man will die at forty, but he knows the percentage of men who will die at forty in any large community. It is perfectly possible for the behaviour of the individual to be unpredictable, and yet for the behaviour of large masses to be determinate. It is in this sense, and this sense only, that laws of nature exist and *that scientific prediction is possible*.

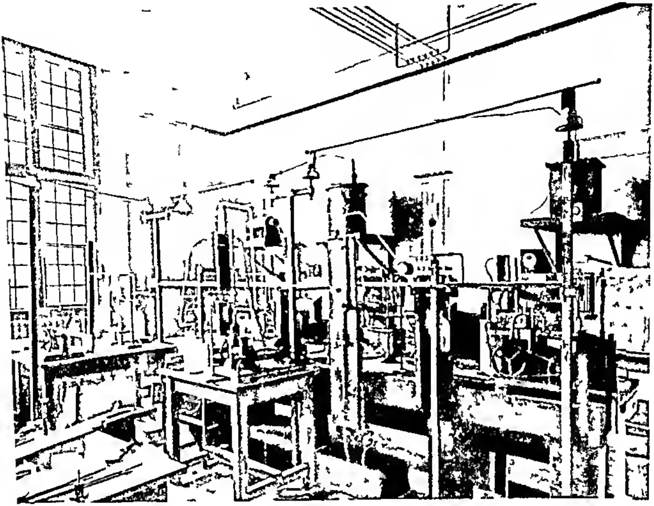
To return: in the case of the free electron its movement is not determinate. It is "determined by no known laws." It is impossible to tie an electron down exactly to a definite starting point, or to say that it must appear at any given place. There is always a certain indeterminancy of position, and indefiniteness as to the nature of the activity. There seem to be

[illegible] Press

SHAKESPEARE

What would he have said to the idea that there is no such thing as individual freedom of will?

Men at some time are masters of their fates
The fault, dear Brutus, is not in our stars
But in ourselves, that we are underlings



[Photo Bristol Physics Laboratory

A MODERN RESEARCH LABORATORY

A typical and up to date research room in the Bristol Physics Laboratory, where important experiments are carried out in demonstration of the new theories in physics

" equally probable " choices of its behaviour Only its probable position can be fixed Probabilities imply events As one writer puts it Hence the study of an electron in an atom is much like the study of a crowd, each member of which is endowed with free will and is therefore at liberty to do as he pleases Thus it happens that the atom is regarded as a collection of events rather than as a substantial entity '

Has the electron free will ?

The electron moves and behaves in its own mysterious way and, as we have already said, we must regard it as having a kind of free will of its own The grounds for this statement are accepted by most, but not all, mathematical physicists Professor G P Thomson who has conducted some striking experiments, in explaining certain technical points in atomic behaviour says that ' this cuts the bottom from under the argument for determinism " We have already quoted a similar emphatic statement of Eddington, and we could go on quoting many other eminent physicists of to day to the same effect

Some great physicists, like Schrodinger, for example, declare that the ultimate happenings in the physical universe are not predestined Thus the present and the future are not uniquely determined by the past Others no less eminent, we may repeat, believe that while this " free-

will" theory may be triumphant at present, the next phase of physics may restore a complete determinism

§ 3
CONCLUSION

SUCH is the revolution, then, in scientific thought, and, as it may turn out to be, in philosophic thought, effected by the study of the quantum theory But yet the nature of the electron is not solved Its properties remain a mystery Sir J J Thomson (to whom, perhaps, more than to any other man the discovery of the electron is due) thinks that "the properties of the electron recently discovered lead to the view that the electron is not the final stage in the structure of matter but that it has itself a structure, being made up of smaller parts which carry charges of electricity such a structure would give to it the properties it has lately been found to possess"

The doctrine of "determinism"

The doctrine of the old time 'materialism' has gone, and for the present so also it would seem has the doctrine of "determinism" Who would have imagined that a study of the atom and the electron and the quantum would have had so much to say on the problems that have been hitherto the province of speculative philosophy

We must not think that all these theories are scientifically proved Up to now they are, to the best belief of mathematical physicists, true, but there is no reason to assume that they have reached the limit of things knowable The ideas of physicists on the problems we have been dealing with are to a large extent derived from mathematical equations and the interpretations given to them

These ideas and interpretations may be found to be wrong or incomplete We have said little about the philosophical implications of these new discoveries What has to be said with reference to that has been said in another section of this work (*see* Chapter IV, Part III)

§ 4
RECENT DISCOVERIES

IN the account of the atom we have given we have described it as composed of two sorts of electric particles, the proton and the electron This description may be sufficient to give the layman a general view of the fact of atomic structure, but not sufficient for those who wish to know this structure in detail Recent researches have considerably complicated the simplicity of the proton electron theory of the atom This complication has come from both the mathematical and experimental sides

The *neutron* and the *positron*

From the experimental side comes the discovery that there are other entities, besides simple protons and electrons, entering into the constitution of matter One of these is the *neutron*, and another newly discovered entity is the *positron* These discoveries do not affect the description of the atomic theory we have given so far A third discovery is that of the heavy hydrogen atom We have seen that the atom of ordinary hydrogen consists of one proton with one electron circulating round it The new hydrogen atom which has been discovered has a nucleus consisting of two protons and one electron Around this nucleus circulates one electron as in ordinary hydrogen When this heavy hydrogen combines with oxygen to form water the water so formed differs markedly from ordinary water It is denser it has a higher freezing point and a higher boiling point, and it is fatal to various forms of life which flourish in ordinary water In any ordinary sample of water a small percentage of this heavy water is present Its precise effect on the living organism is obviously a matter of great interest and is now being investigated

CHAPTER VII

THE STORY OF EVOLUTION

IN this section we shall confine ourselves as closely as possible to a description of the stages in the evolution of life, as they are conceived by present-day science, from the lowliest creatures to the highest that has moved through the ages *from less to more* The progression of life on earth has no other rational interpretation. The confirmatory evidence supplied by various branches of science we shall refer to later The multiplicity of " evidences " of evolution are overwhelming

[H J Shepstone

HOW THE EARTH MAY HAVE COME INTO EXISTENCE

The story of evolution (if we may use the word in connection with inanimate as well as animate nature) tells of an infinitely gradual and variable progression from less to more from cosmic dust to man as he is to day The vast prelude to the earth s existence has been fully dealt with under Astronomy In the present chapter we tell the story, so far as is known of the appearance of organic life

The theory of the origin of the earth thought to be the most likely is that a great nebular mass condensed to form the sun from which under the attraction of a passing star planet after planet the earth included, was heaved off in the form of knotted spiral nebulæ

Evolution is no longer a theory but an accepted fact of science Apart from arguable *processes, or facts in evolution, the fact of evolution seems* to be indisputable No other hypothesis of how things have come to be what they are proves a reasonable one All the facts point the same way and *in* the result give to all animate nature a unity and an intelligent understandableness that otherwise it has not All living things are regarded as part of one great creative system

The word "*evolution*," so commonly used, is not so definite in meaning as one might think One authority says that, as the word is now used, it means the universal process of orderly *change* It includes cosmic changes in suns and planets and organic changes in living creatures Here the term is unrestricted as applied to evolution of atoms, molecules, the

solar system, and not alone to living things such as plants and animals. In this *unrestricted* sense it is applied also to human races, to social institutions, to political thought and scientific thought, and so on. The word "evolution," however, used in this way has not the same meaning as it has when restricted to the evolution of living organisms. Here it is individual organic evolution—which is not found in atoms or molecules, suns or stellar systems. Organic evolution is not found till the level of living creatures has been reached. It is the principle of *life* which introduces something that is new and distinctive, and which "differentiates" organic from inorganic evolution. The restricted meaning of the word is, then, only applied to organic evolution.

What is *common to both* is "the upward passage of states and of status; the upward passage from lower to higher, no matter what particular form this passage may assume in this or that kind of progress." And of evolution in this sense there is evidence in molecules, in organisms, in minds, and in social institutions.

We have seen in earlier chapters of this work something of the "evolution" of stars and suns, and of atoms and molecules. We have seen cosmic gaseous matter far out in space becoming nebulæ, and nebulæ becoming stars, and stars stellar systems; and in particular we have noted the sun that gave birth to our own planet, the earth. All that on a gigantic scale.

At the opposite extreme, the extreme of minuteness, we have seen how infinitesimally small particles of electricity have built up atoms, and atoms molecules, and molecules the solid, material, everyday, physical world. The basic physical constitution of everything, stars and suns, plants and trees, bird and beast is the same—particles of electricity.

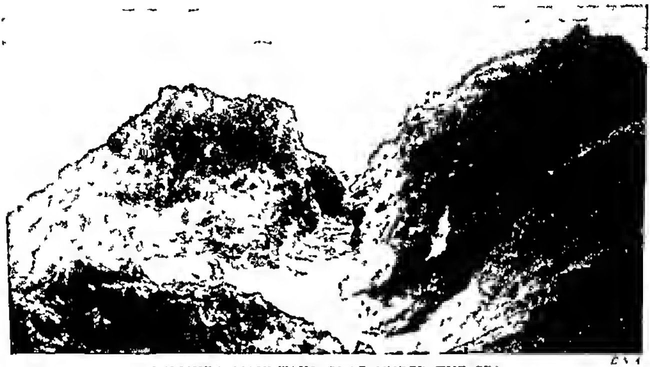
But what we have to deal with here is individual organic evolution, the evolution of living organisms. How life came to a lifeless world science does not know.* The belief is that life appeared at some particular stage in our planet's history. Most biologists believe that life on the earth originated from the matter of the earth at some remote but definite time in history, and that "all our terrestrial activities played a necessary part in its origin." How the earth, a lifeless world, is supposed to have come into being we have already told in Chapter V. We need not repeat the story here. Astronomers put the age of the earth at two thousand million years; on other methods of calculation it might be about double that. Life first began to appear on the earth, it is supposed, one thousand million years ago.

Life appeared, however it arose. All living organisms, including man himself, are traced back to the remote start of some single-celled creature, then, in higher gradations, on to some sort of fish, to amphibians, to reptiles, to birds, to lower mammals, to ape-like creatures, to tentative man, and then *homo sapiens*. In the evolutionary process we do not, of course, imagine one species being suddenly transformed into another; we do not think of a reptile being transformed straightaway into a bird, or a bird into a mammal, or an ape into a man. We have to think of a long drawn out process during which variants arose from an ancestral stock. These variants started on a new line of advance from which others and again others followed an urge of some kind, until eventually a veritable new creature had emerged.

In other words, we have to think of evolution as a continuous sequence of slow transformations, "in the course of which, apart from conservative types remaining unchanged for millions of years, apart also from eddies, parasitisms, retrogressions, and degeneracies, there is, on the whole, a persistent advancement of life."

Sir J. Arthur Thomson expresses it lucidly in these words: "Organic evolution may be defined as a racial movement in a definite direction (or in definite directions), in the course of which new types emerge and survive, either in place of or alongside of those from which they arose, all apparently occurring by continuous processes of change which admit of scientific description or give promise of so doing. When we say continuous we mean that there are no gaps though there may be jerks. When we say

* This subject is discussed in the section dealing with Biology.



BERMUDA MOUNTAIN, ONCE UNDER THE SEA

Millions of years ago Bermuda Mountain in the Western Atlantic nosed its way to the upper air through two miles of ocean the process constituting a geological phenomenon which Dr Beebe explains as due to the lowering of the ocean bed itself If a pail of water is allowed partly to freeze over night and the ice then removed the level of the remaining water will be considerably lowered So many years ago in the Pleistocene great wind storms carried away vast quantities of water drawn up into clouds from the oceans and deposited as snow over all the northern land of the world The snow then turned into ice and pushed southward and the first glacial epoch began Little by little as more water piled up on the land the level of the Atlantic Ocean sank and Bermuda Mountain came nearer to the surface Finally when over a half mile thickness of ice had formed, the level of the sea was lowered over two hundred and fifty feet leaving Bermuda high and dry

scientific description we mean that a coherent account is more or less possible in terms of verifiable factors There is no jookery pawkery"

§ 1

Making a Home for Life

It is interesting to inquire how the callous rough and tumble conditions of the outer world in early days were replaced by others that allowed of the germination and growth of that tender plant we call LIFE There are very tough living creatures but the average organism is ill suited for violence Most living creatures are adapted to mild temperatures and gentle reactions Hence the fundamental importance of the early atmosphere, heavy with planetesimal dust, in blanketing the earth against intensities of radiance from without, as Chamberlin says, and inequalities of radiance from within This was the first preparation for life, but it was an atmosphere without free oxygen Not less important was the appearance of pools and lakelets, of lakes and seas Perhaps the early waters covered the earth And water was the second preparation for life—water, that can dissolve a larger variety of substances in greater concentration than any other liquid, water, that in summer does not readily evaporate altogether from a pond, nor in winter freeze throughout its whole extent, water, that is such a mobile vehicle and such a subtle cleaver of substances, water that *forms* over 80 per cent of living matter itself

[Photo J J Ward

ONE CELLED ORGANISMS

As the earth cooled conditions encouraged the growth of more capable organisms Amongst these were single celled plants the originators of the vegetable kingdom that could manufacture chlorophyll i e green pigment This enabled them to utilize the energy of sunlight The above are fresh water Desmids a species of Algæ of great beauty They belong to the family of the first pigment making marine plants

Of great significance was the abundance of carbon hydrogen and oxygen (in the form of carbonic acid and water) in the atmosphere of the cooling earth, for these three wonderful elements have a unique *ensemble* of properties—ready to enter into reactions, making great diversity and complexity possible, favouring the formation of the plastic and permeable materials that build up living creatures We must not pursue the idea, but it is clear that the stones and mortar of the inanimate world are such that they built a friendly home for life

Origin of Living Creatures upon the Earth

During the early chapters of the earth's history no living creature that we can imagine could possibly have lived there The temperature was too high, there was neither atmosphere nor surface water Therefore it follows that at some uncertain, but inconceivably distant date, living creatures appeared upon the earth No one knows how, but it is interesting to consider possibilities

From ancient times it has been a favourite answer that the dust of the earth may have become living in a way which is outside scientific description This answer forecloses the question, and it is far too soon to do that

A second position, held by Helmholtz, Lord Kelvin, and others, suggests that minute living creatures may have come to the earth from elsewhere, in the cracks of a meteorite or among cosmic dust It must be remembered that seeds can survive prolonged exposure to very low temperatures, that spores of bacteria can survive high temperature, that seeds of plants and

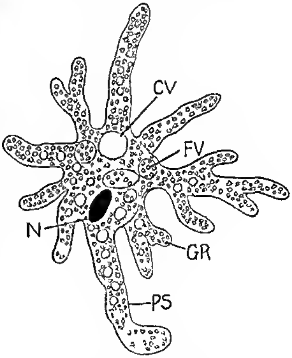
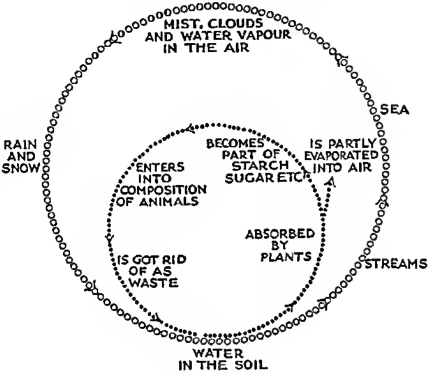


DIAGRAM OF AN AMŒBA

Some organisms were unable to extract a living from air or water They therefore devoured other organisms Amœba are not enclosed in cellulose Their naked protoplasm reaches out in all directions in search of food How the amœba absorbs food by means of its outflowing lobes is shown at (PS) The food vacuole (FV) contains ingested food From the contractile vacuole (CV) waste matter is discharged (N) is the nucleus (GR) the granules Marine organisms such as the amœba were the forerunners of the animal kingdom

germs of animals in a state of "latent life" can survive prolonged drought and absence of oxygen It is possible, according to Berthelot, that as long as there is not molecular disintegration vital activities may be suspended for a time, and may afterwards recommence when appropriate conditions are restored Therefore one should be slow to say that a long journey through space is impossible The obvious limitation of Lord Kelvin's theory is that it only shifts the problem of the origin of organisms (i e living creatures) from the earth to elsewhere

The third answer is that living creatures of a very simple sort may have emerged on the earth's surface from not-living material, e g from some semi-fluid carbon compounds activated by ferments The tenability of this view is suggested by the achievements of the synthetic chemists, who are able artificially to build up substances such as *oxalic acid, indigo, salicylic* acid, caffeine, and grape sugar We do not know, indeed, what in Nature's laboratory would take the place of the clever synthetic chemist, but there seems to be a tendency to complexity Corpuscles form atoms, atoms form molecules, small molecules large ones



' WATER WAS THE SECOND PREPARATION FOR LIFE

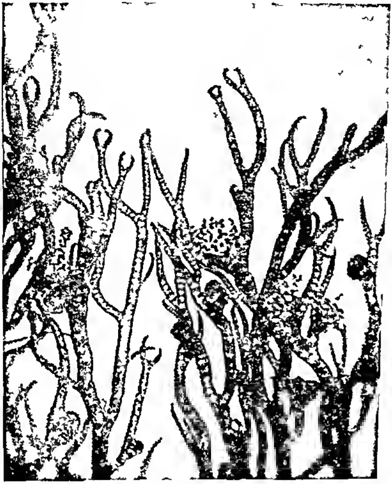
Water forms over 80 per cent of matter itself it was not until the waters began to cover the earth that life got its chance The diagram shows the perpetual chemical and physical cycle of water In the outer circle water passes from the soil to streams and thence to the sea It rises as mist from the sea and forms clouds Thence it is precipitated as rain and snow, and is water once more in the soil In the inner circle the water in the soil is absorbed by plants is partly lost as vapour but is partly used in building up carbon compounds These are eaten by animals and the surplus water returns to earth

So far as we know of what goes on to day, there is no evidence of spontaneous generation , organisms seem always to arise from pre-existing organisms of the same kind , where any suggestion of the contrary has been fancied there have been flaws in the experimenting But it is one thing to accept the verdict *omne vivum e vivo* as a fact to which experiment has not yet discovered an exception, and another thing to maintain that this must *always* have been true or must always remain true

The First Organisms upon the Earth

We cannot have more than a speculative picture of the *first* living creatures upon the earth, or, rather, in the waters that covered the earth A basis for speculation is to be found, however, in the simplest creatures living to day, such as some of the Bacteria and one celled animalcules, especially those called Protists, which have not taken any very definite step towards becoming either plants or animals No one can be sure, but there is much to be said for the theory that the first creatures were microscopic globules of living matter, not unlike the simplest Bacteria of to day, but able to live on air, water, and dissolved salts From such a

source may have originated a race of one-celled marine organisms which were able to manufacture chlorophyll, or something like chlorophyll, that is to say, the green pigment which makes it possible for plants to utilise the energy of the sunlight in breaking up carbon dioxide and in building up (photosynthesis) carbon compounds like sugars and starch



[Photo J J Ward

THE PRIMEVAL MARINE FOREST

Another great step in evolution was taken when bucklings of the earth's crust led to the establishment of continents In the inshore waters shallow enough to receive sunlight primeval forms of marine life anchored themselves to rocks and grew into green threads and plates thus beginning the great family of sea weeds

The above is a large genus of red sea weed whose thread like fronds are made up of several parallel tubes, hence its name "many syphons" (Polysiphonia)

On another tack, however, there *probably* evolved a series of simple predatory creatures not able to build up organic matter from air, water, and salts, but devouring their neighbours These units were not closed in with cellulose, but *remained* naked, with their living matter or protoplasm flowing out in changeful processes, such as we see in the Amœbæ in the ditch or in our own white blood corpuscles and other amœboid cells

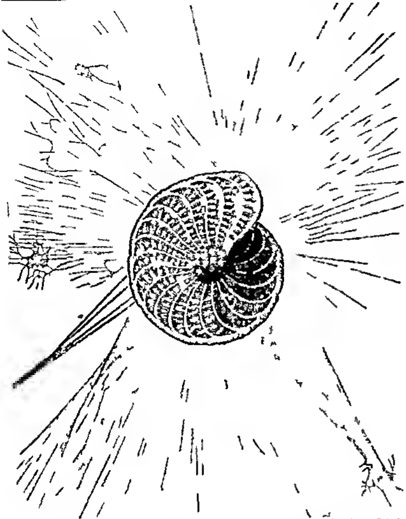
Originators of the Vegetable Kingdom

These little units were probably *encased in* a cell-wall of cellulose, but their boxed in energy expressed itself in the undulatory movement of a lash or flagellum, by means of which they propelled themselves energetically through the water There are many similar organisms to day, mostly in water, but some of them—simple one celled plants—paint the tree stems and even the paving-stones green in wet weather

According to Professor A H Church, there was a long chapter in the history of the earth when the sea that covered everything teemed with these green flagellates—the originators of the Vegetable Kingdom

Originators of the Animal Kingdom

These were the originators of the animal kingdom Thus from very simple Protists the first animals and the first plants may have arisen All were still very minute, and it is worth remembering that had there been any scientific spectator after our kind upon the earth during these long ages, he would have lamented the entire absence of life, although the seas were teeming The simplest forms of life and the protoplasm which Huxley called the physical basis of life will be dealt with in the chapter on Biology in a later section of this work



[After Max Schultze

FORAMINIFERA

Foraminifera or chalk forming animals some not much larger than a pinhead are encased in shells of amazingly beautiful architecture usually made of limestone

The enormously enlarged illustration is that of a common foraminifer (Polystomella) showing the shell in the centre and the outflowing network of living matter along which granules are continually travelling and by which food particles are entangled and drawn in

One of the great steps in evolution was the establishment of types of Protozoa of which foraminifera are one The vast majority of Protozoa are too complicated to be thought of as primitive Though most of them are microscopic each is an animal complete in itself with the same fundamental bodily attributes as are manifested in ourselves They differ from animals of higher degree in not being built up of the unit areas called cells

FIRST GREAT STEPS IN EVOLUTION

HOWEVER it may have come about there is no doubt at all that one of the first great steps in Organic Evolution was the forking of the genealogical tree into Plants and Animals—the most important parting of the ways in the whole history of Nature

Typical plants have chlorophyll they are able to feed at a low chemical level on air water and salts using the energy of the sunlight in their photo synthesis They have their cells boxed in by cellulose walls so that their opportunities for motility are greatly restricted They manufacture much more nutritive material than they need and live far below their income They have no ready way of getting rid of any nitrogenous waste matter that they may form and this probably helps to keep them sluggish

Animals on the other hand feed at a high chemical level on the carbohydrates (*e g* starch and sugar) fats and proteins (*e g* gluten albumin casein) which are manufactured by other animals or to begin with by plants Their cells have not cellulose walls nor in most cases much wall of any kind and motility in the majority is unrestricted

The Beginnings of Land Plants

It is highly probable that for long ages the waters covered the earth and that all the primeval vegetation consisted of simple Flagellates in the universal Open Sea But contraction of the earth s crust brought about elevations and depressions of the sea floor and in places the solid substratum was brought near enough the surface to allow the floating plants to begin to settle down without getting out of the light This is how Professor Church pictures the beginning of a fixed *vegetation—a* very momentous step

in evolution It was perhaps among this early vegetation that animals had their first successes As the floor of the sea in these shallow areas was raised higher and higher there was a beginning of dry land The sedentary plants already spoken of were the ancestors of the shore seaweeds, and there is no doubt that when we go down at the lowest tide and wade cautiously out among the jungle of vegetation only exposed on such occasions we are getting a glimpse of very ancient days *This* is the forest primeval

The Protozoa

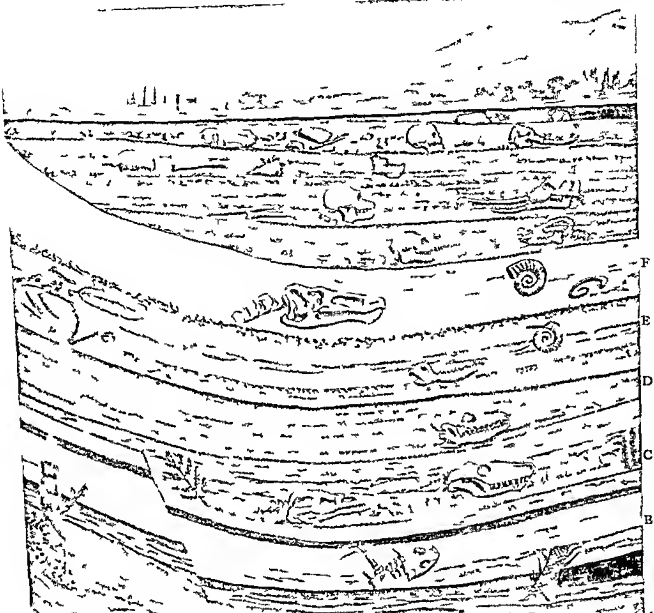
Animals below the level of zoophytes and sponges are called Protozoa The word obviously means "First Animals," but all that we can say is that the very simplest of them may give us some hint of the simplicity of the original first animals For it is quite certain that the vast majority of the Protozoa to day are far too complicated to be thought of as primitive Though most of them are microscopic, each is an animal complete in itself, with the same fundamental bodily attributes as are manifested in ourselves They differ from animals of higher degree in not being built up of the unit areas or corpuscles called cells They have no cells, no tissues, no organs, in the ordinary acceptation of these words, but many of them show a great complexity of internal structure, far exceeding that of the ordinary cells that build up the tissues of higher animals They are complete living creatures which have not gone in for body making

THE PROCESSION OF LIFE THROUGH THE AGES

WE shall pause in our narrative for a moment to answer the question How do we know when the various classes of animals and plants were established on the earth? How do we know the order of their appearance and the succession of their advances? The answer is by reading the Rock Record In the course of time the crust of the earth has been elevated into continents and depressed into ocean troughs, and the surface of the land has been buckled up into mountain ranges and folded in gentler hills and valleys The high places of the land have been weathered by air and water in many forms, and the results of the weathering have been borne away by rivers and seas, to be laid down again elsewhere as deposits which eventually formed sandstones, mudstones, and similar sedimentary rocks Much of the material of the original crust has thus been broken down and worked up again many times over, and if the total thickness of the sedimentary rocks is added up it amounts, according to some geologists, to a total of sixty-seven miles In most cases, however, only a small part of this thickness is to be seen in one place, for the deposits were usually formed in limited areas at any one time

When the sediments were accumulating age after age, it naturally came about that remains of the plants and animals living at the time were buried, and these formed the fossils by the aid of which it is possible to read the story of the past By careful piecing together of evidence the geologist is able to determine the order in which the different sedimentary rocks were laid down, and thus to say, for instance, that the Devonian period was the time of the origin of Amphibians In other cases the geologist utilises the fossils in his attempt to work out the order of the strata when these have been much disarranged For the simpler fossil forms of any type must be older than those that are more complex There is no vicious circle here, for the general succession of strata is clear, and it is quite certain that there were fishes before there were amphibians and amphibians before there were reptiles, and reptiles before there were birds and mammals In certain cases, *e g* of fossil horses and elephants, the actual historical succession has been clearly worked out

If the successive strata contained good samples of all the plants and animals living at the time when the beds were formed, then it would be easy to read the record of the rocks, but many animals were too soft to become satisfactory fossils, many were eaten or dissolved away, many were destroyed by heat and pressure, so that the



PICTORIAL REPRESENTATION OF THE SUCCESSIVE STRATA OF THE EARTH'S CRUST WITH SUGGESTIONS OF CHARACTERISTIC FOSSILS

The lowest strata shows invertebrate marine creatures of the Cambrian era. Then follow Fish and Trilobites in the Devonian (A), a large Amphibian in the Carboniferous (B), Reptiles in Permian (C), the first Mammal in the Triassic (D), the first bird in the Jurassic (E), Giant Reptiles in the Cretaceous (F). Then follows the Tertiary strata with progressive mammals and Quaternary at the top with man and mammoth.

[Photo J J Ward

A DROP OF POND WATER
(Highly magnified)

A single drop of water from a densely peopled pond may show under the microscope a great variety of organisms such as water fleas minute crustaceans rotifers and animalcules minute worms several kinds of infusorians and various simple plants such as desmids and diatoms It is usually necessary to try several drops if one is to see much This drop shows volvox diatoms desmids and more

rock record is like a library very much damaged by fire and looting and decay

§ 2

The Geological Time Table

THE long history of the earth and its inhabitants is conveniently divided into eras Thus just as we speak of the ancient, mediæval, and modern history of mankind, so we may speak of Palæozoic, Mesozoic, and Cenozoic eras in the history of the earth as a whole

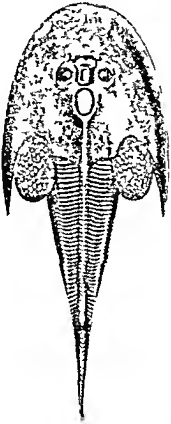
Geologists cannot tell us except in an approximate way how long the process of evolution has taken One of the methods is to estimate how long has been required for the accumulation of the salts of the sea, for all these have been dissolved out of the rocks since rain began to fall on the earth Dividing the total amount of saline matter by what is contributed every year in modern times, we get about a hundred million years as the age of the sea But as the present rate of salt accumulation is probably much greater than it was during many of the geological periods the prodigious age just mentioned is in all likelihood far below the mark Another method is to calculate how long it would take to form the sedimentary rocks, like sandstones and mudstones, which have a *total* thickness of over fifty miles though the *local* thickness is rarely over a mile As most of the materials have come from the weathering of the earth s crust and as the annual amount of weathering now going on can be estimated, the time required for the formation of the sedimentary rocks of the world can be approximately calculated There are some other ways of trying to tell the earth's age—for example, that based on the rate of production of lead from uranium, lead results from the degeneration of uranium and the age of igneous rocks in the earth s surface in which uranium free from the admixture of lead has degenerated into uranium lead can be calculated The length of the successive periods in geological time can also be calculated, but no certainty has been reached

The eras marked on the table (page 302) as

before the Cambrian correspond to about thirty-two miles of thickness of strata, and all the subsequent eras with fossil-bearing rocks to a thickness of about twenty-one miles—in itself an astounding fact. Perhaps thirty million years must be allotted to the duration of Pre-Cambrian eras, many millions to the duration of the Palæozoic, fewer, but still millions, to the Mesozoic and to the Cenozoic.*

It is an astounding fact that at least half of geological time (the Archæozoic and Proterozoic eras) passed before there were living creatures with parts sufficiently hard to form fossils. In the latter part of the Proterozoic era there are traces of ***one-celled marine*** animals (Radiolarians) with shells of flint and of worms that wallowed in the primal mud. It is plain that as regards the most primitive creatures the rock record tells us little.

The rarity of direct traces of life in the oldest rocks is partly due to the fact that the primitive animals would be of delicate build, but it must also be remembered that the ancient rocks have been profoundly and repeatedly changed by pressure and heat, so that the traces which did exist would be very liable to obliteration. And if it be asked what right we have to suppose the presence of living creatures in the absence or extreme rarity of fossils, we must point to great accumulations of limestone which indicate the existence of calcareous algæ, and to deposits of iron which probably indicate the activity of iron-forming Bacteria. Ancient beds of graphite similarly suggest that green plants flourished in these ancient days.



[Photo British Museum

FOSSIL OF AN EARLY FISH

(*Cephalaspis Lyelli*)

It belonged to the Upper Silurian period and was one of the first true fishes as apart from molluscs. The large head is covered with a hard shield. It had embryonic fins in addition to the small flexible tail but its swimming power was limited.

§ 3

THE ERA OF ANCIENT LIFE (PALÆOZOIC)

FOR long ages there were no backboned animals, or Vertebrates, only backboneless animals. The *Cambrian* period was the time of the establishment of the chief stocks of backboneless animals, such as sponges, jellyfishes, worms, sea-cucumbers, lamp-shells, trilobites, crustaceans, and molluscs. There is something very eloquent in the broad fact that the peopling of the seas had definitely begun some thirty million years ago, for Professor H. F. Osborn points out that in the Cambrian period there was already a colonisation of the shore of the sea, the open sea, and the deep waters.

The *Ordovician* period was marked by abundant representation of the once very successful class of Trilobites—jointed-footed, antenna-bearing, segmented marine animals, with numerous appendages and a covering of chitin. They died away entirely with the end of the Palæozoic era. Also very notable was the abundance of predatory cuttlefishes, the bullies of the ancient seas. But it was in this period

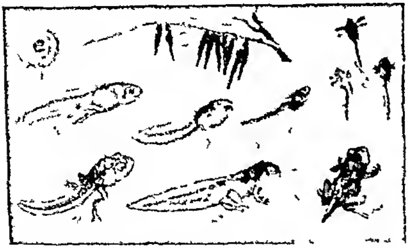
* "As a matter of fact, prehistory archæology has no date. But archæology, like geology, has a chronology of sequences ascertained from types of their associated contents, which is sufficient for scientific purposes."

that the first backboned animals made their appearance—an epoch making step in evolution In other words, true fishes were evolved—destined in the course of ages to replace the cuttlefishes (which are mere molluscs) in dominating the seas

In the *Silurian* period the peopling of the seas went on apace, there was the first known attempt at colonising the dry land For in Silurian rocks there are fossil scorpions and that implies ability to breathe dry air—by means of internal surfaces, in this case known as lung books It was also towards the end of the Silurian, when a period of great aridity set in, that fishes appeared related to our mud fishes or double breathers (Dipnoi), which have lungs as well as gills This, again, meant utilising dry air, just as the present day mud fishes do when the water disappears from the pools in hot weather The lung fishes or mud fishes of to day are but three in number, one in Queensland, one in South America, and one in Africa, but they are extremely interesting "living fossils," binding the class of fishes to that of amphibians It is highly probable that the first invasion of the dry land should be put to the credit of some adventurous worms, but the second great invasion was certainly due to air-breathing Arthropods, like the pioneer scorpion we mentioned

Ages passed, and in the time of the Old Red Stone there was an emergence of Amphibians What steps of progress they seem to have made—the acquisition of fingers and toes, true lungs, nostrils, vocal cords, a movable tongue, a three chambered heart, and so on It was an epoch

FORMATIVE TIMES	Establishment of the solar system Cooling of the earth Beginnings of atmosphere and hydrosphere Making of continents and ocean basins	
ARCHÆOZOIC AGES *PROTEROZOIC AGES*	Living creatures begun to be upon the earth Many of the backboneless stocks began	
PALÆOZOIC ERA	CAMBRIAN PERIOD	Peopling of the sea
	ORDOVICIAN PERIOD	First fishes
	SILURIAN PERIOD	Land animals began
	DEVONIAN PERIOD	First amphibians
	CARBONIFEROUS PERIOD	Rise of insects
	PERMIAN PERIOD	Rise of reptiles
MESOZOIC ERA	TRIASSIC PERIOD	Rise of dinosaur reptiles
	JURASSIC PERIOD	Rise of birds and flying reptiles
	CRETACEOUS PERIOD	Rise of primitive mammals, flowering plants, and higher insects
CENOZOIC ERA	EOCENE AND OLIGOCENE TIMES	Rise of higher mammals
	MIOCENE AND PLIOCENE TIMES	Emergence of man
	PLEISTOCENE OR GLACIAL TIME	Last Great Ice Age
RECENT TIMES		Human civilisation



A GREAT STEP IN EVOLUTION

The emergence of Amphibians was a great step in evolution (see text) The first use of the voice was probably that indicated by our frogs and toads Huxley and Haldane write (in *Animal Biology* *) ' At first reading the statement that frogs resemble men in any important degree may perhaps raise a smile It is nevertheless true We can recognise in the frog a great many parts that exist in our selves, arranged moreover in the same way A frog possesses a head, a trunk and fore and hind limbs The nostrils eyes ear-drums, and mouth are arranged in the same relative positions as in our head If we look at the skeletons of man and frog we shall find that both possess a skull, a backbone consisting of separate jointed pieces or vertebræ the same type of limb bones the same kind of teeth If we dissect them, we shall in both discover red blood, a heart in the front of the trunk and on the ventral surface, a liver, a pair of kidneys, a spleen, a nerve cord within the backbone and a great many other organs which have a family likeness to each other, and are to be found in similar positions in the bodies of the two organisms "

Its life history is interesting The frog probably recapitulates in the various stages of its development the processes of evolution accomplished over millions of years by the whole race of amphibians (1) Before hatching, (2) Newly hatched larvæ hanging on to a water weed, (3) with external gills, (4) external gills are covered over and are absorbed, (5) limbless larvæ about a month old, with internal gills, (6) tadpole with hind legs about two months old, (7) with the fore limbs emerging, (8) with all four legs free, (9) a young frog about three months old, showing the almost complete absorption of the tail and the change of the tadpole mouth into a frog mouth

making advance, though they remained frog-witted creatures even when they reached their golden age in the Carboniferous period

The *Devonian* period, including that of the Old Red Sandstone, was one of the most significant periods in the earth's history For it was the time of the establishment of flowering plants upon the earth and of terrestrial backboned animals One would like to have been the discoverer of the Devonian footprint of *Thinopus*, the first known Amphibian footprint—an eloquent vestige of the third great invasion of the dry land It was probably from a stock of Devonian lung-fishes that the first Amphibians sprang, but it was not till the next period that they came into their own While they were still feeling their way, there was a remarkable exuberance of shark like and heavily armoured fishes in the Devonian seas

§ 4

Evolution of Land Animals

THE *Carboniferous* period was marked by a mild moist climate and a luxuriant vegetation in the swampy low grounds It was a much less strenuous time than the Devonian period, it was like a very long summer There were no trees of the type we see now, but there were forests of club-mosses and horse tails, which grew to a gigantic size compared with their pigmy representatives of to day In these forests the jointed-footed invaders of the dry land ran riot in the form of centipedes, spiders, scorpions, and insects, and on these the primeval Amphibians fed

The appearance of insects made possible a new linkage of far-reaching importance, namely, the cross-fertilisation of flowering plants by their insect visitors, and from this time onwards it may be said that flowers and their visitors have evolved hand in hand Cross-fertilisation is much surer by insects than by the wind, and cross-fertilisation is more advantageous than self-fertilisation because it promotes both fertility and plasticity It was probably in this period that *coloured* flowers—attractive to insect-visitors—began to justify themselves as beauty become useful, and began to relieve the monotonous green of the horse-tail and club-moss forests, which covered great tracts of the earth

* *Oxford University Press*

for millions of years In the Carboniferous forests there were also land snails, representing one of the minor invasions of the dry land tending on the whole to check vegetation They, too, were probably preyed upon by the Amphibians, some of which attained a large size Each age has had its giants, and those of the Carboniferous were Amphibians called Labyrinthodonts, some of which were almost as big as donkeys *It was in this period that most of the coal measures were laid down by the immense accumulation of the spores and debris of the club-moss forests Ages afterwards it was given to man to tap this great source of energy—traceable back to the sunshine of millions of years ago* Even then it was true that no plant or animal lives or dies to itself!

Big Advances

As Amphibians had their Golden Age in the Carboniferous period we may fitly use this opportunity of indicating the advances in evolution which the emergence of Amphibians implied (1) In the first place the passage from water to dry land was the beginning of a higher and more promiseful life, taxed no doubt by increased difficulties The natural question rises why animals should have migrated from water to dry land at all when great difficulties were involved in the transition The answers must be (*a*) that local drying up of waterbasins or elevations of the land surface often made the old haunts untenable, (*b*) that there may have been great congestion and competition in the old quarters, and (*c*) that there has been an undeniable endeavour after well being throughout the history of animal life

In the same way with mankind, migrations were prompted by the setting in of prolonged drought, by over-population, and by the spirit of adventure (2) In Amphibians for the first time the non digitate paired fins of fishes were replaced by limbs with fingers and toes This implied an advantageous power of grasping, of holding firm, of putting food into the mouth, of feeling things in three dimensions (3) We cannot be positive in regard to the soft parts of the ancient Amphibians known only as fossils, but if they were in a general way like the frogs and toads, newts and salamanders of the present day, we may say that they made among other acquisitions the following true ventral lungs, a three-chambered heart, a movable tongue, a drum to the ear, and lids to the eyes It is very interesting to find that though the tongue of the tadpole has some muscle fibres in it, they are not strong enough to effect movement, recalling the tongue of fishes, which has not any muscles at all Gradually, as the tadpole becomes a frog, the muscle fibres grow in strength and make it possible for the full grown creature to shoot out its tongue upon insects This is probably a recapitulation of what was accomplished in the course of millenia in the history of the Amphibian race (4) Another acquisition made by Amphibians was a voice, due, as in ourselves, to the rapid passage of air over taut membranes (vocal cords) stretched in the larynx It is an interesting fact that for millions of years there was upon the earth no sound of life at all, only the noise of wind and wave, thunder and avalanche Apart from the instrumental music of some insects, perhaps beginning in the Carboniferous, the first vital sounds were due to Amphibians, and theirs certainly was the first voice—surely one of the great steps in organic evolution

(*To be continued on p* 345)

BOOK III—(*Continued from page 260*)

THE DEVELOPMENT OF RELIGIOUS THOUGHT AND MODERN DISCOVERY

CHAPTER III

THE RISE OF CHRISTIANITY

[Photo American Colony Jerusalem]

ANTIOCH THE BIRTHPLACE OF GENTILE CHRISTIANITY

Christianity was born into a world torn with political dissension and a world of many religious and philosophical beliefs the story of its rise is told in the text

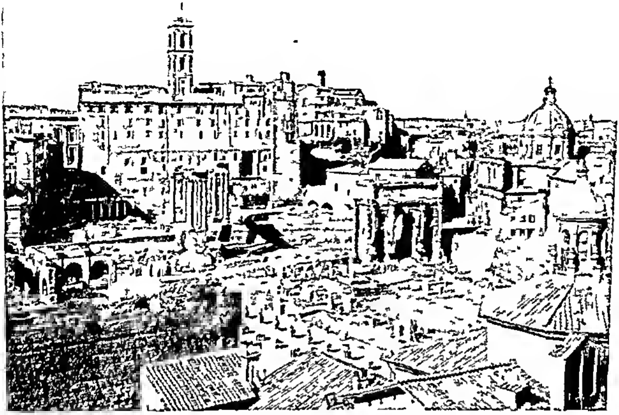
The name of Christians was first given to the little community of Nazarenes at Antioch in Northern Syria where they had taken refuge from official Judaism and Roman oppression It was here too that the convert Paul gathered around him a great crowd of disciples

IN Chapter II we brought the history of the development of Hebrew religion down to the dawn of the Christian era The Jewish nation rejected Jesus of Nazareth as the national Messiah, Judaism remained the national religion The small number of Jews who accepted Jesus as the Messiah formed the Nazarene community of the first Christians

We also traced the contemporaneous development of Greek religion in its various forms, bringing that also down to the dawn of the Christian era

We have seen in both cases the same gradual development of religious ideas, from crude beginnings to high conceptions of a Supreme Being creator and governor of the universe With the Hebrews the progression was from a tribal god to One God of the whole earth With the Greeks, from the Olympic gods, and the worship of nature divinities, to the mystic and symbolical Eleusinian and Orphic mystery religions on the one hand, and on the other the metaphysical speculations of the philosopher with their soaring conceptions of an unseen world —the idealistic world pictured in Platonic philosophy

We did not go into this deeply, for we are merely tracing the general developments of religious ideas in the



[Photo Anderson

THE FORUM ROME

Showing the column of Phocas the Tabularium and the Arch of Septimus Severus When the Christian era dawned the golden age of Greece had passed and Rome was entering on her decline "Truly" says the historian Mommsen "it was an old world and even the patriotic genius of Cæsar could not make it young again" The common people were ready to listen to any prophet or teacher who offered them spiritual release

old world This is not the place to describe the various schools of Greek philosophy, although some knowledge of their teaching is necessary for any one who would understand the later development of Christian theology and ecclesiastical doctrine To both not only Platonic and Aristotelian philosophy contributed their part, but also the philosophical school of the Stoics, ethical both in aim and doctrine The teaching of the great philosophers was too intellectual for the common people, but that did not prevent philosophical ideas, in the hands of learned men becoming part and parcel of Christian theology and doctrine But we are anticipating For our business now is to resume the story of religious development from the point we left off, namely at the dawn of the Christian era We said that we should see a certain coalescence of the old religions with the new As the Christian era dawned we find "not only a soil ready for the seed of Christian metaphysic, but a large number of the plants already in full and exuberant growth"

§ 1

The World at the Dawn of the Christian Era

THE state of the world when the first century A D, as we call it now, began, was full of trouble We shall begin our narrative by quoting the words of a great historian picturing this world of the first century, the Golden Age of Greece had passed, and Rome was entering on her decline

There was in the world as Cæsar found it

the rich and noble heritage of past centuries, and an endless abundance of splendour and glory, but little soul, still less taste, and, least of all, joy in and through life. Truly it was an old world, and even the patriotic genius of Cæsar could not make it young again. The blush of dawn returns not until the night has fully descended. Yet with him there came to the much tormented nations of the Mediterranean a tranquil evening after a sultry day."

In these words of the historian Mommsen (translated by Lord Bryce) the temper of the world into which Christianity was born is admirably indicated. Through the length and breadth of civilisation there was an almost conscious feeling that humanity had come to the end of its journey. After all the ages of strife and speculation and debate, life had reached an equilibrium, and might be expected henceforth to pursue an even, placid, unadventurous course. The radiant Greek dreams of political liberty had been extinguished in the vast and cumbrous stagnation of the Roman empire; but at the same time the petty conflicts in which they had generally found practical issue were stilled in the Roman peace; and a disillusioned generation had learned to prefer it so. In like manner the soaring aspirations of the philosophers after some solution of the problem of the universe had ended in negation, and the sages were content now to propound rules of life for men who knew not, and had ceased greatly to care, whence they came and whither they were to go. Even in Judæa the trumpet-tones of the prophets were silenced and replaced by the lecturing voices of the doctors of the law.

[Photo Mansell

ISIS AND HORUS

Among the many cults in vogue among the Romans at the time when Christian theology was being formulated was that of the worship of Isis and Horus. The mystical background of the cult was borrowed from the Egyptians.

Sir James Frazer says: "*Her worship was one of the most popular at Rome and throughout the Empire. Some of the Roman emperors themselves were openly addicted to it. Her rites appear on the whole to have been honourably distinguished by a dignity and composure, a solemnity and decorum well fitted to soothe the troubled mind, to ease the burdened heart. We need not wonder, then, that in a period of decadence, when traditional faiths were shaken, when systems clashed, when men's minds were disquieted, when the fabric of empire itself, once deemed eternal, began to show ominous rents and fissures, the serene figure of Isis with her spiritual calm, her gracious promise of immortality, should have appeared to many like a star in a stormy sky, and should have roused in their breasts a rapture of devotion not unlike that which was paid in the Middle Ages to the Virgin Mary. Indeed her stately ritual, with its shaven and tonsured priests, its matins and vespers, its tinkling music, its baptism and aspersions of holy water, its solemn processions, its jewelled images of the Mother of God, presented many points of similarity to the pomps and ceremonies of Catholicism. In art the figure of Isis suckling the infant Horus is so like that of the Madonna and child that it has sometimes received the adoration of ignorant Christians.*"

In material wealth and power such as none of the great empires had attained, Rome seemed to have gained the whole world and destroyed its soul. Civilisation had become jaded and listless, though for that very reason many men and women, dissatisfied with a world that seemed occupied only with its own material prosperity, were ready to listen to almost any prophet or preacher who claimed to offer them spiritual release. Throughout the great Empire, but especially in its teeming and cosmopolitan capital, exotic faiths and superstitions from the East found

[Photo Mansell

ECCE HOMO

After the famous painting by Ciseri representing the final scene of the arraignment of Jesus of Nazareth by the Roman governor of Jerusalem Pontius Pilate

eager acceptance, and proliferated exceedingly in the fallow fields that the fashionable scepticism had laid waste Their appeal was mostly to emotion in an age a little tired of intellectual "enlightenment" From Phrygia came the worship of the Great Mother with its mixture of cruelty and asceticism from Egypt the necromantic mysticism of Isis and Serapis from Persia a little later the solar revivalism of Mithra

Common to all these cults and many others was the teaching that man has here no abiding city, that there is a higher life to which he may be heir, and a higher power in whose being he may participate *Nor was it only among the susceptible masses that these hopes stirred* Among the greatest minds of Rome we can see, as the age of the Republic ends the formulation of a belief in human survival, conditioned by the moral law, which nothing in the traditional mythology justified "This theory of life and death," *writes Sir Samuel Dill of its expression* in Virgil "coming down from Pythagoras and popularised by Platonism, with some Stoic elements, had gained immense vogue among educated men of the last period of the Republic"

§ 2

TO this world of men 'sitting in darkness and in the shadow of death' came, towards the end of what we now call the first century A D, news of a religion that claimed to give what all sought, the *assurance of continuing life* Such an assurance was offered in varying degree by the philosophers and by the mystagogues, but this new religion of Christianity differed from all

others in this, that instead of basing its hope on *a priori* reasoning or mythological allegory it put forward the plain clear-cut statement of fact that a man had, quite recently and at a time and place precisely stated, actually risen from the dead Many of the preachers of the new faith had actually known this Jesus of Nazareth, they had accompanied him about Judæa proclaiming his message, they had been with him when he was arrested by the orders of the Jewish priesthood, arraigned before the Roman governor, and put to death on a charge of treason by the terrible process of torture known as crucifixion They had seen him die, they were personal witnesses of the disappearance of his body from its tomb, and, they said, they had subsequently met and spoken with him on more than one occasion They even asserted that they had seen him received up into the sky He had left them the charge to go out and proclaim to the world that just as he himself had triumphed over physical death, so also was it possible for those who would follow in his footsteps to do likewise

[Photo American Colony Jerusalem

A GALILEAN JEWISH SYNAGOGUE

The partially restored Jewish Synagogue at Tell Hum the site of ancient Capernaum on the northern shore of the Sea of Galilee Galilean Judaism was closer in touch with Greek ideas and oriental philosophy than that of Judea It was the Christianity of the Galilean apostles that St Paul expanded and amplified and in doing so encountered opposition from his fellow Apostles (See page 320)

This circumstantial narrative of a literal death and a literal resurrection is the essence of Christianity as first presented to the world All else —its exalted moral code, its sacramental system, its exposition of the nature of God and his purpose for the world—was subordinate to this, and, in the eyes of the earliest missionaries, meaningless without it "If Christ be not risen, then is our preaching vain, and your faith is also vain"

This teaching, being addressed in the first instance by Jews to a Jewish audience, was expressed in the form of a fulfilment of Jewish prophecy The master who had proved his authority by so stupendous a marvel could be no other than Messiah, the long expected deliverer of the chosen people, the King of the Jews But, contrary to the current interpretation of the Messianic prophecies, his kingdom was "not of this world" He had not come to overthrow the Roman Empire and restore the political independence of Israel Rather had he founded a spiritual "kingdom of God" of which all who followed him might become citizens, and

his disciples foretold that, though apparently defeated by his priestly enemies, he would come again from his seat in heaven to establish this kingdom and with it the reign of righteousness for ever

The First Christian Community

Such a doctrine could not be preached with impunity in the Jerusalem of the first century Official Judaism tolerated a wide divergence of theological opinion—the mere existence side by side of the Pharisee and Sadducee sects would prove so much But it could scarcely tolerate the identification of the dreamed-of embodiment of the nation's hopes with a condemned felon whom the priests had themselves handed over to the executioners Hence the little community of the Nazarenes (Christian " appears to have been a nickname coined a little later at Antioch) grew up under the shadow of persecution Its leaders were imprisoned and flogged, and one of their chief lieutenants, an early convert named Stephen, was put to death by stoning on a charge of blasphemy For a time, indeed after this the society was compelled to disperse, but it came together again before long

This first group of pioneers did not for some time conceive of themselves as standing apart from the religious beliefs of their race They had no theology and no literature of their own, and scarcely any organisation They accepted all the sacred books of Judaism, but they interpreted them as pointing to the climax of Jewish history in the mission of their crucified and risen leader, and in his personality they found the explanation of the whole

It was in this concentration of their thoughts on the personality of their master that they stood apart, and not in any revolutionary code of morals Ethically, the Christian teaching differed little from Jewish morality in its loftiest and purest form Jesus had summed up the duty of a Christian in one sentence

> Thou shalt love the Lord thy God with all thy heart and with all thy soul and with all thy strength and with all thy mind and thy neighbour as thyself

This sentence is a mere juxtaposition of two quotations from the Pentateuch, and illustrates Christ's repeated declaration that he came not to destroy the law of Moses but to fulfil it So at first his followers continued to live the strict Jewish life, illumined however by certain ideas directly connected with the personality of Jesus These ideas were afterwards to be expressed in much more exact form, but at this time they were very imperfectly defined The core of them was this that Jesus was in some sense divine—" the Son of God," he had called himself, that by virtue of his power, and particularly by the merits of his death, which he could if he had so chosen have avoided, they might become purified of the taint of sin, and that thus purified and made members of his consecrated society they became heirs of the Kingdom of God, in which they would enjoy eternal felicity after the return of the Master and the end of the world—both events were expected to take place in a very short time

§ 3

How Christianity Took Shape

BEFORE we go on to sketch the rise of Christianity to the time when it became established as the state religion of the Roman Empire, let us briefly consider (1) What Christianity was for the Apostles themselves (2) How the Christianity of these Galilean apostles was transformed by that great original genius St Paul and became a system of Pauline theology (3) How as its geographic boundaries extended, and it made a wider appeal, it assimilated various ideas, rites, and ceremonies from the pagan mystery religions which had been developing in Greece and elsewhere for several previous centuries (4) How also it was built up into a system of theology permeated by ideas drawn from Greek philosophy and Neo Platonism (5) How finally a body of propositions or doctrines was embodied in the formularies of an institutional Church

When we have done that, and it can be done here only briefly, we shall consider some modern interpretations and evaluations of Christianity in the light of modern knowledge and present-day thought It has been remarked that It

PAUL ESCAPES FROM DAMASCUS
By Reginald Hallward
Driven from Damascus he contrived to escape down the city wall in a basket and made his way to

[Photo Bill F Taylor

THE ROCKY HILLS OF JUDÆA

It was across such deserted sun bitten dusty heights as these that Jesus of Nazareth and his disciples travelled by foot from one place to another in the scattered Judæan world

"But, even so, it is still, I think, remarkable how soon, when we search the early authorities on which alone sober Church history can be built, we discover that there are only three of the twelve about whose careers any detailed information exists—Peter, James, and John About these alone have the Synoptic Gospels, the Acts, or the Epistles anything in particular to record" *

We must free our minds, as Dr Streeter says, of the traditional picture of the twelve apostles sitting at Jerusalem, like a college of Cardinals, settling doctrine and superintending the organisation of the primitive Church There was no such thing 'They had a more urgent work to do The Day of Judgment was at hand Their duty was to call men to repent before it was too late When the Lord might any day return in glory, it was unprofitable to build up an organisation about which the one thing certain was that it was never meant to last' They were not interested either in the definition of doctrine or in the theory of Church order, 'the hammer of the world s clock was raised to strike the last hour" Thus, they believed, their Master had taught them, the second coming was conceived of, at first, as an imminent event likely to take place in the lifetime of those who had known him on earth, they believed that in some sense he was divine they believed in his Messiahship, they believed that he had risen from the dead, they believed that for them and all true believers, a place was reserved in the coming Kingdom (Whether the

is a far cry from the Sermon on the Mount to the creeds of the fourth century,' and it may be added it is also a far cry from the fourth century to the twentieth The predominant fact we note in the earliest days of Christianity is the pre dominant fact that has always marked it up until our own day—the foundation of the faith which characterised the earliest disciples was the personality of Jesus

How did Christianity take shape in the age of the apostles? History, says Canon Streeter, is strangely silent about what became of the twelve apostles Their twelve years' residence in Jerusalem may rest on genuine tradition

* *The Primitive Church* By Dr Streeter (Macmillan & Co)

Apostles had a completely wrong impression of Christ's teaching regarding the Kingdom of Heaven is a subject on which we need not enter.)

Christian Origins

Those who have made any study of Christian origins know how difficult it is even for scholars to piece together an accurate and connected story of the origins of the primitive Church of the Christian Ministry, of Church government or even what were accepted doctrines. Streeter tells us that there was a far greater diversity and variety in primitive Christianity than is commonly recognised. There were diversities in the earliest churches diversities which had their origin in the Apostolic age we find them even in the Gospels.

There existed in the sub Apostolic age a high degree of local independence even in regard to matters which must have been considered as of supreme importance. These early churches founded in the manner they were (not always by Apostles or trained missionaries but by unnamed Jews of the Dispersion) differed from one another ' differed according to the degree of knowledge and insight of the first enthusiast who preached there according also to the temper and type of their earliest converts. There was one Lord one faith one baptism but the content of that faith varied enormously from place to place (Streeter.)

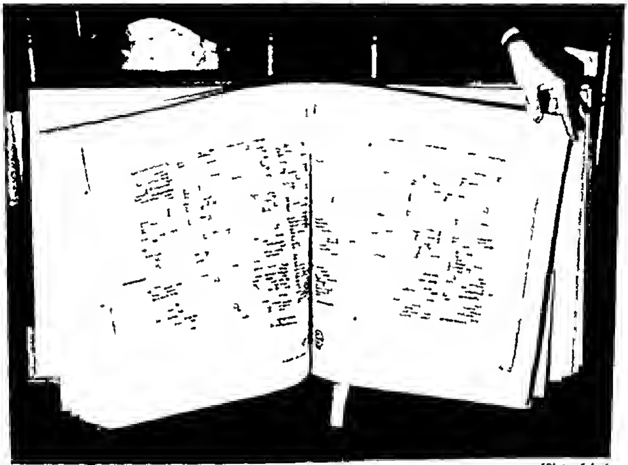
The history of Christianity during the first five centuries is the history of a progressive standardisation of that diversity. It was during the earlier part of the period of maximum independence— in regard to doctrinal emphasis, church organisation the religious literature most valued, and also in regard to the manuscript tradition of such books as they had in common' —that the Gospels were written.

As the men who had known Jesus grew old it became increasingly urgent to put down in writing their memories of the Master's life. A great number of such biographies were provided nearly all purporting to be the work of eye witnesses. The majority of these were undoubtedly spurious and were soon rejected by the main body of the Church. Four remain whose authenticity was generally accepted. There is good reason to suppose that the writers of the three Synoptic Gospels had access to earlier documents now lost.

[Photo Will F Taylor

PALESTINE

The Garden of Gethsemane and Mount of Olives seen from the Eastern Wall Jerusalem



[Photo L.N.A

THE FOURTH CENTURY CODEX SINAITICUS

It ranks with the Codex Vaticanus as one of the two oldest manuscripts of the Greek Bible being a century older than the Codex Alexandandrium One of the proofs of its authenticity and age is the existence in its margins of the section numbers compiled for the Gospels by *Eusebius who died in* A.D *340* Other evidence goes to show that it cannot have been written later than the fourth century A.D The manuscript was discovered in 1844 in the monastery of St Catherine at Mount Sinai by a German scholar Tischendorf who rescued some of its leaves from the furnace It was sold to the Tsar of Russia and subsequently *offered to the British Nation* by the Soviet Government and bought in 1933 for the sum of £100 000

[Photo: Anderson]

PAUL PREACHING AT ATHENS

By Raphael

He had to meet the keen, subtle, intellectual questioning of the Athenians, and frame his message in a way that would appeal to their philosophical minds. He began to formulate a theology, and contrasted the Christian God "with the gods whom ye ignorantly worship."

[Photo Anderson

ST PETER VISITED IN PRISON BY ST PAUL

A fresco by Masaccio

How Saul the Jewish Pharisee became Paul the Christian his transformation from arrogant Rabbi to zealous preacher and missionary of Christianity is described in the text Paul was himself imprisoned and scourged for preaching the new faith

little doubt that they are based upon early and in the main reliable sources *

The fourth gospel is entirely different from *the three Synoptic Gospels It is clearly the* work of a mind of poetic cast with some philosophical training and far more interested in ideas than in events Apart from the story of The Passion at the end it is mainly thrown into the form of a series of discourses put into the mouth of Jesus but apparently rather intended to exhibit his teaching in a conventionalised form as Plato did with the teaching of Socrates than to claim strict historical actuality for the speeches themselves The theology that is written between the lines of this gospel is the theology of Paul though making use of certain ideas developed by the Jewish philosopher Philo the author introduces a new and potent concept into Christian thought This is the Logos the Word which may perhaps be defined as the personification of the eternal creative power of God and the temporary fusion of the Logos with a human personality is the author s explanation of *the mystery of Christ s nature The* origin and development of this doctrine of the Logos (going back to Plato) we shall see in a moment

Who that author was is the subject of another great controversy Tradition makes him John the last survivor of the twelve apostles writing down in extreme old age the memories of his youth If this be true or even if the gospel in any sense represents John s personal testimony though written down by some pupil after his

* Professor F C Burkitt writes Professor R Bultmann of Marburg is one of the most influential of the younger theologians in Germany his literary analysis of the sources is to be found in his *History of the Synoptic Tradition* (19 1) and his view of the Gospel Sayings in his *Jesus* (1926) In Bultmann s opinion the Sayings are all that is historical the tales of Jesus together with the general framework of the Gospel History he regards as a product of the missionary needs of early Hellenistic Christianity Jesus was an eschatological prophet a herald of the coming kingdom or rule of God no doubt He was crucified and believed by disciples to have been seen alive again but that is all we know about Him for certain according to Bultmann

Professor Burkitt is very far from sharing this view and gives strong reasons for dissenting from it

[Photo Alinari

THE STONING OF ST STEPHEN

By Lorenzo Lotto

Paul of Tarsus was a violent persecutor of Nazarenes He hunted them out from synagogues they were scourged and he had voted for their execution the persecution culminated in the martyrdom of Stephen by stoning Paul was a witness of the young saint being battered to death by howling fanatics It made a great impression on him

Dr Inge writes Stephen s speech may have made him indignant his heroic death the very ideal of martyrdom must have awakened very different feelings

death it is an independent confirmation of the Pauline version of Christianity which is of the greatest possible weight But a large body of modern criticism denies to it any such status and places its origin well into the second century A.D If these critics are right it is ultimately derivative from Paul and not a separate piece of evidence that his interpretation is authentic

The Ultimate Source of Christian Dogma

In all this we see how difficult it is to distinguish fact from interpretation the ultimate source of Christian dogma as Dr W R Matthews insists is the experience of the Founder of Christianity himself The inner life of Jesus his towering divine originality contain elements which are *beyond our conjecture* That is fundamental His experience was in the fullest sense creative creative of new life and of new concepts

At what point does interpretation come in? At the very outset at the fountain head of Christian faith and life we cannot find datum without interpretation Fact and interpretation are inextricably intertwined Dr Matthews is thus expressing the same point of view as Dr Inge The religious experience of Jesus not only expressed itself in but flowed into moulds which were provided by the thought and imagery of His race and time Again There is no need to labour the point that St Paul presents a religious experience coloured to an indefinite degree by interpretative ideas '

Dr Matthews is thoroughly ' modernist ' when he writes The idea that the Gospels are simple and unprejudiced accounts of the objective

spheres of human endeavour It is burning zeal, undaunted courage, will power born of inward conviction, and in Paul's case self sacrifice and profound assurance *that he was fulfilling* a mission to which he had received a special call from God He was a great organiser, reformer, and theologian

Paul (or Saul) of Tarsus in his earlier life was a learned Pharisee of the school of the Rabbi Gamaliel In Paul the Jewish Pharisee, and Paul the Christian, we have a vivid *contrast* The Pharisees were a so called "Jewish sect" or school They took their stand upon the Law, ' together with those inferences drawn from its written letter which had, partly from time immemorial, been current as a sacred tradition among the people" They scrupulously observed certain ordinances relating to things clean and unclean They wished the State and all its political doings to be directed and measured by the standard of the Law, without regard for the priestly and aristocratic families There were sharp differences between the religious beliefs of the Pharisees and Sadducees Paul the Pharisee had imbibed the spirit of fanatical hatred against the new sect called the Nazarenes (early Christians) and the new Gospel which tended to the overthrow of the Pharisees' cherished idols and the formalities enjoined by the Law Paul of Tarsus was a violent persecutor of Nazarenes He hunted them out from synagogues, they were scourged, and he had *voted for their execution*, *the persecution* culminated in the martyrdom of Stephen by stoning Paul was a witness of the young saint ' being battered to death by howling fanatics ' It made a great impression on him Dr Inge writes ' Stephen's speech may have made him indignant, his heroic death the very ideal of martyrdom, must have awakened very *different* feelings"

Paul's Vision

When Paul had *finished* his work as an inquisitor at Jerusalem, he set out to root out the odious sect of Nazarenes from Damascus On this journey he met the *crisis of his life* in a dazzling vision

Dr Inge asks "What caused the sudden change which so astonished the survivors among his victims? To suppose that nothing prepared for the vision near Damascus, that the apparition *in the sky* was a mere '*bolt from the blue*' is an impossible theory" Dr Inge answers the question "An undercurrent of dissatisfaction, almost of disgust, at the arid and unspiritual seminary teaching of the Pharisees now surged up and came very near the surface His bigotry sustained him as a persecutor for a few weeks more, *but how, if* he could himself *see what* the dying Stephen said that he saw? Would *not* that be welcome liberation? The vision came in the desert, where men see visions and hear voices to this day They were very common in the desert of Gobi when Marco Polo traversed it" We do not take this as implying that Dr Inge questions the phenomenon of "conversion,' it is merely a piece of constructive psycho analysis

An amazing transformation, a complete parting of the ways, from self sufficient, arrogant Rabbi, from a travelling lecturer on philosophy, Paul becomes a zealous preacher and missionary of Christianity

He began to preach the very gospel which he had spent his life hitherto in trying to destroy ' Driven from Damascus," says one biographer of Paul ' by Jewish animosity, he contrived to escape down the city wall in a basket, and made his way to Jerusalem where, as was natural, he was received with coldness and suspicion After a trance and vision in the Temple, in which *his future destiny was foreshadowed* to him, he was driven to Tarsus by a plot to murder him" At Lystra on one occasion he was stoned by the Jews and left for dead, he probably carried on him the marks of his wounds to his last day He travelled extensively, preaching and founding churches At Troas he saw the vision of the '*man of Macedonia*" which led to his great decision to carry the Gospel into Europe At Philippi he was scourged and imprisoned, he was driven by the Jews from Thessalonica, and so from place to place Probably all the time he was supporting himself by his trade of tent maker Often he had to flee from plots to murder him He had to face not only all the hardships of travel but ' all the cruelty of the fanaticism

[*H. J. Shepstone*

THE WILDERNESS OF JUDÆA

Showing (right-hand corner) the historic Brook Kerith. (*The Brook Kerith* is the title and subject of the late Mr. George Moore's well-known work.) A photograph taken from the air which illustrates the deserted character of the country around Jerusalem. St. Paul, on his long journeys between Damascus and Jerusalem, may have passed through a wilderness such as this where, as Dr. Inge suggests, "men see visions and hear voices to this day."

which rages like a consuming fire through the religious history of the East."

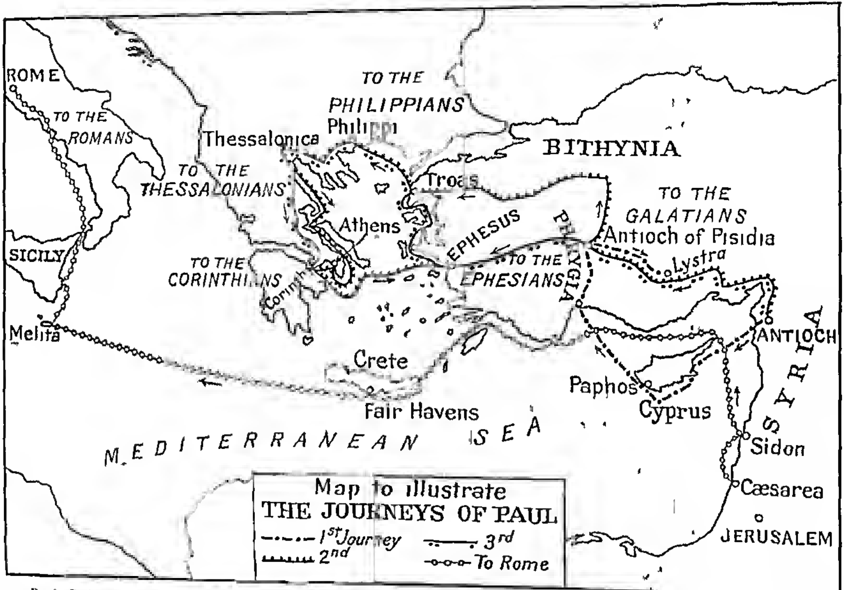
Dr. Inge believes that Paul intended to go to Rome "and thence to Spain—a scheme worthy of the restless genius of Alexander. He saw Rome, indeed, but as a prisoner. The rest of his life is lost in obscurity. The writer of the Acts does not say that the two years' imprisonment ended in his execution; and if it was so, it is difficult to see why such a fact should be suppressed. If the charge against him was at last dismissed, because the accusers did not think it worth while to come to Rome to prosecute it, St. Luke's silence is more explicable. In any case, we may regard it as almost certain that St. Paul ended his life under a Roman axe during the reign of Nero." *

Such then, in brief, was the life of St. Paul.

* *Outspoken Essays*. By Dean Inge (Longmans & Co.).

St. Paul's Theology

We have now to consider in what way St. Paul altered, amplified, and expanded the Christianity of the Galilean apostles. In principle, as Dean Inge remarks, "he committed himself from the first to the complete emancipation of Christianity from Judaism." To the Jewish Christian, Jesus was the national Messiah; a Messiah they expected to return when they would see revived, and on a grander scale, the glories of the golden age of David. These, says the Dean, were the chief articles of faith in Judaistic Christianity "This was, however, only the framework. What attracted converts was really the historical picture of the life of Jesus; his message of love and brotherhood, which they found realised in the little communities of believers; and the abolition of all external barriers between human beings, such as social position, race, and sex,



But for Paul of Tarsus Christian ty could not have flourished He travelled extensively preaching and found ng Churches The map shows the outward course of the four chief missionary journeys which Paul undertook often under cond tions of great danger and privation Each journey brought new converts and a widening of the range of Christianity The last journey, to Rome, resulted in Paul s f nal imprisonment, trial and death

facts of the life of Jesus has long been abandoned by students, and they are recognised as being plainly documents for the propaganda and instruction in the Christian faith, written to set forth Jesus as Messiah and Saviour They are thus not themselves pure data unmixed with interpretation The dogmatic motive is fundamental " *

§ 4

THE PART PLAYED BY ST. PAUL

WE come now to the second point, the part played by St Paul, the greatest figure in the history of Christianity, and a great original genius Paul was probably born about the same time as Jesus, who died at the age of thirty It is very unlikely that Paul ever saw him, if he did, it was as a hostile critic Paul was a Jew, but a Roman citizen by birth He was a working artisan, a "tent-maker," and according to the standards of his time he was highly educated He has been described as "bald-headed, bow-legged, strongly built, a man small in size, with meeting eyebrows, with a rather large nose, full of grace, for at times he looked like a man and at times he had the face of an angel His temperament was choleric and impetuous, his nervous organism finely strung and quivering with sensibility; there was nothing in him of the impressive stoic " He studied under Gamaliel, one of the great Rabbis at Jerusalem

[Photo Anderson

LA PIETA
By Michael Angelo

Sir James Frazer suggests that the type created by Greek artists, of the sorrowful goddess with her dying lover in her arms may have been the model of the Pieta of Christian art the Virgin with the dead body of her divine Son in her lap There are many such instances of the adaptation by the early Church of pagan conceptions to the new Christian faith

Probably he meant, says Dr Inge, to be a Jerusalem Rabbi himself, still practising his trade, as the Rabbis usually did "He suffered from some obscure physical trouble, the nature of which we can only guess It was probably epilepsy, a disease which is compatible with great powers of endurance and great mental energy, as is proved by the cases of Julius Cæsar and Napoleon He was liable to mystic trances, in which some have found a confirmation of the supposition that he was epileptic " All that we really know of his life lies in the thirty years between A.D 36 and A D 66, which form its central period The secret of Paul s unparalleled success and his dominance is simply the secret of all great men in religion, in politics, in all

* *Dogma in History and Thought* Edited by W R Matthews (Nisbet.)

calls "*my* gospel" (Rom ii 16), was based on his own experiences, on the religious ideas present in his own mind, and on his own conception of the significance of Jesus and his place in the history of mankind, in "the whole counsel of God" That, as Professor Bethune-Baker remarks, "involved inferences as to existing ideas and institutions which not all the leaders of the new society were ready to accept" St Paul was a thinker, a disciplined mystic philosopher, an originator of a schematic theology What was new and strange to some of his fellow Christians belonged to the framework of St Paul's mentality

§ 5

Birth of Christian Theology

It would be going beyond our province to expound fully the ways in which Pauline theology, in the range and reach of its development, travelled far from the original Gospel preaching It is also outside our scope to discuss whether St Paul's theology deflected the subsequent history of Christianity, whether after the gospel of Christ passed through the interpretative medium of his mind it was left substantially unchanged, certainly he introduced a highly theological element It is mostly due to him that Christianity became a world religion

The pastoral care of the apostles for the local churches they had founded was the occasion of the *birth of Christian literature* Paul the one intellectual giant among them, was responsible for the largest contribution In the midst of his continual travels he took every opportunity of writing long and profoundly argued letters to his converts, sometimes addressing a whole church in a document obviously meant to be read aloud at the meeting for prayer, sometimes writing more personally to the individual disciple whom he had left behind as bishop In these letters we have the first attempt to endow the Christian religion with a theology

A Theology Necessary

A theology was necessary for two reasons. Paul had brought Christianity out from among the simple-minded Galileans who had seen its beginnings, and exposed it to the criticism of the subtle and questioning Greeks, who always wanted answers to the questions how and why Paul found many among his converts who were familiar with other religious and philosophical systems, and were inclined to graft ideas from them upon the Christian stock Some of these were felt to be incompatible with the truths for which Christianity stood But before the falsehoods could be refuted it was necessary to have a reasoned statement of what the truths were He had to meet hostile criticism by intellectual arguments and in terms of Hellenic thought

We shall see in a moment what the principal ideas of St Paul were, and the question immediately arises, are they a true representation of the teaching of Jesus Christ, the carpenter of Nazareth? On the one hand, they are intensely sophisticated, in form Oriental Greek rather than Jewish, and the more they are studied in detail, the more do they recall the main features of the mystery religions But it may be argued that they seem to have been accepted without demur by the men who had actually lived with Jesus, since no earlier Christian writings than Paul's have come down to us the existence of any purer form of the gospel, from which he can be accused of departing, must be pure supposition

Generally it may be said that St Paul began to assert far more about the crucified Lord than the bare fact of his Messiahship and the conceptions of him formed by his followers In Christ he saw something of a vast positive significance for the whole of humanity, but to discuss here Pauline theology, as exemplified in his doctrine of God, the doctrine of the Divinity of Jesus and his doctrines of Redemption, Justification, Reconciliation, and Faith, forms no part of our purpose

At first it would appear that he had shared in the conviction of the primitive Christian community that the coming of Christ would take place very shortly, if so, that expectation gave place to an elevated conception of the future life, a conception opposed to the Jewish notions of any triumph of individual or national aspirations

and in contradiction to the Jewish doctrine of a future life which posited a resurrection of the corporeal frame, he categorically asserted that "flesh and blood cannot inherit the Kingdom of God" (He may have meant these words in the sense that human immortality comes as a supernatural gift and not as a natural right) "He rejected all suggestion of a future existence in a disembodied state and taught that for the fleshly body would be substituted a body, frame, or form which belonged to the spirit world"

Paul saw the principle of the new life in the Holy Spirit, the Spirit of God or the Spirit of Christ To the Jewish and primitive Christian conception of the Spirit he gave a development and an application which appears to have been original with him For he ascribed to the Spirit character, initiative purposive action ethical quality which together represent what we mean by personality He read the character and discerned the purpose of the Spirit from his knowledge of the character and purpose of Jesus *

This mystical doctrine of the Spirit (immanent in the soul of the believer) says Dr Inge, was "a conception which was the core of St Paul's personal religion, and more than anything else emancipated him from apocalyptic dreams of the future . The doctrine of the Spirit as a present possession of Christians brings down heaven to earth and exalts earth to heaven" Dr Inge adds "It is useless to deny that St Paul regarded Christianity as, at least on one side, a mystery-religion" All we have been saying about Pauline theology is, we presume, generally admitted, if not always in the set terms we have used, some regard "mystery" as inherent in the teaching of the Master himself, and lay stress on that mystical significance †

* Dr F J Foakes Jackson in *Christianity in the Light of Modern Knowledge*

† ' It is a confusion of thought to say that if the Christian Church makes an essential part of its Gospel something which is found in the teaching of Paul and is not found in the teaching of Jesus that is to put Paul as a teacher above Jesus For according to the Christian faith the chief significance of Jesus is not in what he taught but in what he was and in what he did and if he did not himself explain in words the significance of what he was and what he did but left that to be explained by his servants under the guidance of his Spirit later on when he was no longer present to the sight of men that is obviously not to make the servant superior to his Lord —Dr Edwyn Bevan in *Christianity* (Home University Library)

(*To be continued on page* 363)

SCIENCE AND MODERN THOUGHT

CHAPTER VIII—(*Continued*)

THE SYSTEM OF ANIMATE NATURE—(*Continued*)

§ 1

WE shall see later something of the adaptations of birds and beasts in tooth and claw, in armour and fighting equipment, to aid them in the struggle for existence and to contend with their environmental conditions We must take the system of animate nature as a whole We must have before our minds the conception of the living creature's re actions and responses to environing difficulties and limitations We must also conceive struggles which are not always those of assertive com petition, for it is true that the struggle is often a struggle after well being, and a struggle for others, often the way is the method of mutual aid, and a subordinating of self to the species, the struggle for existence is to be seen as a struggle against difficulties and limitations that are of Nature's making and that is the large scale view which naturalist and philosopher alike must take If we would under stand the system of Animate Nature, we must study it in its totality Into the large scale view there comes something else than this grim picture we have been describing of wits pitted against wits in the battle of life, of savage warfare of beak and claw, and "crafty running fight or the set ordeal of battle" Bird and beast have to satisfy hunger as human beings have to do It is a primal law of our being

[*Photo Jacques Boyer*

HENRI FABRE

The great French naturalist described by Charles Darwin as that inimitable observer Science owes much to his patient researches and experimental studies in natural history

But a great naturalist reminds us that the observer who sees in Nature nothing but a field of slaughter is just as much astray as he who professes to see nothing but harmony and peace Prince Kropotkin asks 'Who are the fittest those who are continually at war with each other, or those who support one another?' He reminds us that there is 'as much, or even more, of mutual support mutual aid, and mutual defence among animals belonging to the same species or, at least to the same society *Sociability is as much a law of Nature as mutual struggle*" Kropotkin maintains that those animals which acquire habits of mutual aid

are undoubtedly the fittest "They have more chances to survive, and they attain, in their respective classes, the highest development of intelligence and bodily organisation" Mutual aid is as much a law of animal life as mutual struggle, and some would say as a law of Nature mutual aid is the chief factor of evolution The "struggle" as often as not is on a non-competitive basis In the lives of birds and beasts and human beings the welfare of the individual is subordinate to the welfare of the species An eminent authority has said that if he were called upon to explain his conception of the struggle for existence—a phrase often ignorantly misunderstood—he could adduce "from the writings of Darwin himself, and from those of later naturalists, a thousand instances taken from the animal kingdom in which success has come about by means analogous with the cultivation of all the peaceful arts, the raising of the intelligence, and the heightening of the emotions of love and pity" The great fact of Evolution is the primal overruling fact that confronts us In all our philosophising we have to reckon with that The interpretation of it is a consummation beyond the range of the mind of man to conceive, or to guess

The struggle for others is almost as common as the struggle for self Prince Kropotkin is speaking of the social life of animals when he says

> It is not love to my neighbour—whom I often do not know at all—which induces me to seize a pail of water and to rush towards his house when I see it on fire it is a far wider, even though more vague feeling or instinct of human solidarity and sociability which moves me So it is also with animals It is not love and not even sympathy (understood in its proper sense) which induces a herd of ruminants or of horses to form a ring in order to resist an attack of wolves, not love which induces wolves to form a pack for hunting, not love which induces kittens or lambs to play or a dozen of species of young birds to spend their days together in the autumn, and it is neither love nor personal sympathy which induces many thousand fallow deer scattered over a territory as large as France to form into a score of separate herds all marching towards a given spot, in order to cross there a river
>
> It is a feeling infinitely wider than love or personal sympathy—an instinct that has been slowly developed among animals and men in the course of an extremely long evolution, and which has taught animals and men alike the force they can borrow from the practice of mutual aid and support, and the joys they can find in social life

§ 2

AMONG birds and beasts the instinct of mutual aid, association, and social life is no rare thing it is quite common Altruistic instincts are undoubtedly present in the animal world The "struggle" as often as not is on a non competitive basis, as we have said, we may often see that the welfare of the individual is subordinated to the welfare of the species We cannot appeal to the struggle for existence, in the narrow sense of warfare, as a law of Nature in the scheme of Evolution Herbert Spencer held the opinion that the purely self seeking animal is a fiction, "self sacrifice is no less primordial than self-preservation From the dawn of life, altruism has been no less essential than egoism" Examples are not difficult to find the struggle for others is almost as common as the struggle for self

It is a false idea to conceive the struggle for existence as Huxley pictured it in one of his essays "From the point of view of the moralist the animal world is on about the same level as a gladiators' show The creatures are fairly well treated, and set to fight, whereby the strongest, the swiftest, and the cunningest live to fight another day The spectator has no need to turn his thumb down, as no quarter is given" He tells us that, as among primitive men, so among animals, "the weakest and stupidest went to the wall, while the toughest and shrewdest, those who were best fitted to cope with their circumstances—but not the best in another way—survived Life was a continuous free fight, and beyond the limited and temporary relations of the family, the Hobbesian war of each against all was the normal state of existence"

We have already observed that this picture of a "dismal cockpit" where creatures are continually at war with each other is not a true or adequate picture of what Darwin called the

'struggle for existence' That struggle is carried on in quite other ways directed towards the welfare of the species for example, where creatures engage in mutual support, mutual aid and so on

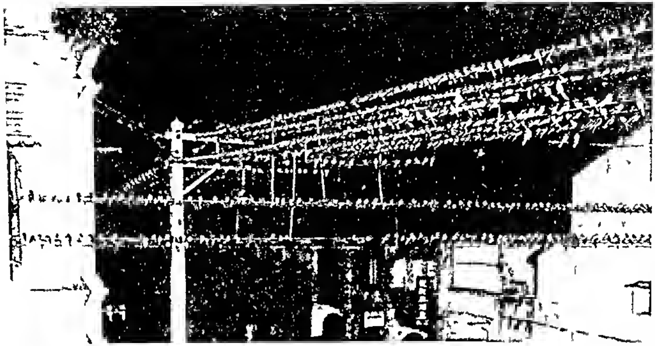
Altruistic behaviour

Before we consider the social life of animals it is interesting and instructive to recall some individual instances of altruistic behaviour and mutual aid witnessed and narrated by observers We may be apt sometimes to read the human into the animal but allowing for all that, there is no question of the altruistic instinct in animal nature Readers of W H Hudson's delightful books may recall several instances of the *helping* instinct characteristic in birds as in other animals Hudson's story of the military starling is perhaps well known, but it will bear repeating

'One day I was sitting on my horse watching a flock feeding and travelling in their leisurely manner, when I noticed a little distance behind the others a bird sitting motionless on the ground

WEASELS PACK HUNTING

An illustration of mutual aid quite common among animals The struggle for existence is as often as not on a non-combative basis Although in no sense social in their ordinary habits Weasels become gregarious when food is short and will combine together for hunting and trekking Working by scent like hounds they travel nose to tail in a long line which at a distance resembles a snake gliding over the ground



[Photo Mondiale

THOUSANDS OF SWALLOWS RESTING TOGETHER ON TELEGRAPH WIRES DURING A MIGRATION

A striking illustration of birds acting in unison for the welfare of the whole

and two others keeping close to it, one on each side These two had finished examining the ground and prodding at the roots of the grass at the spot, and were now anxious to go forward and rejoin the company, but were held back by the other one On my going to them they all flew up and on and I then saw that the one that had hung back had a broken leg

"Perhaps it had not been long broken and he had not yet accommodated himself to the changed conditions in which he had to get about on the ground and find his food I followed and found that, again and again, after the entire scarlet-breasted army had moved on, the lame bird remained behind, his two impatient but faithful companions still keeping with him They would not fly until he flew, and when on the wing still kept their places at his side, and on overtaking the flock all three would drop down together" As Mr Hudson says it is possible to mistake for friendship an action which, at all events in its origin, is a different nature

Mr Frank Finn has related the curious case of a Huia, an insectivorous bird of New Zealand By some accident or natural deformity the bird's upper bill had grown into the shape of a cork-screw, and it was not apparent how it could get enough food to support life naturally It had however, been fed for some time by a devoted mate There is an abundance of well authenticated observations of such compassionate acts J C Wood's narrative of a weasel which came to pick up and to carry away an injured comrade has been frequently quoted Kropotkin recalls the observation of Captain Stansbury on his journey to Utah, which is quoted by Darwin He saw a blind pelican which was fed, and well fed, by other pelicans upon fishes which had to be brought a distance of thirty miles" There is no need to multiply instances, they have been recorded so often by field naturalists that they seem to be quite natural It is true also that there exists sometimes a mutual friendship between individual birds and beasts, companionship between two birds of the same species, or even between birds of different species, is often seen

Mr W H Hudson remarks that the common curlew is the most vigilant of birds, and not vigilant on his own account only 'He is the unsleeping sentinel of all the wild creatures that are pursued by man warning them of danger

with piercing cries that none fail to understand The redshank, greenshank, and many other species, in this and other orders, are equally vociferous in the presence of danger, and their warning are as promptly obeyed by all wild creatures that live with or near them, but a curious feature about the curlew is that he appears to take an intelligent interest in the welfare of beings not of his own species, and that he is distressed if they fail to act on his signal Howard Saunders gives a striking instance of this characteristic He describes one of these birds, "after shrieking wildly over the head of a sleeping seal, swoop down, and apparently flick with its wings the unsuspecting animal, upon which the stalker was just raising his rifle' This to our mind is a far more wonderful instance of the help giving instinct in the lower animals than that related by Edwards of Banff, in which a number of terns swooped down upon one of their number which he had wounded and was pursuing, and, taking its wings in their beaks, raised it and bore it away out to sea beyond his reach

Mr E G Boulenger, writing about recent experiments in connection with the migration problem, gives us the following story about the common white stork of Europe "Apparently the birds mate more or less for life, and though their reputation as models of matrimonial fidelity may not always be justified, many authentic cases of their devotion are on record A particularly pleasant instance is that of a female stork who, by reason of injury to her wing, was compelled to winter in Europe Not only did her faithful spouse visit her regularly every year, but eventually abandoned his southern journeyings entirely, and threw in his lot with a

[Photo H Armstrong Roberts

PELICANS COMBINE TO MAKE A GOOD CATCH

An instance of mutual aid among creatures having a common end in view Pelicans when fishing will take concerted action to ensure a large enough haul of fish Forming themselves into a crescent shaped cordon they wade towards the shore driving large quantities of fish before them the fish are thus cornered and cannot escape Pelicans will often co-operate in order to feed other pelicans unable to join in the hunt Darwin quotes an instance of a blind pelican which was fed by its mates, who brought the fish from thirty miles away

[Photo Capt C W R. Knight

THE SOCIAL ROOKS

A colony of rooks on a March morning exchanging loud calls among the tree tops conveying an impression of communal harmony The rook although inclined to be quarrelsome is a social bird When the nesting time comes rooks form themselves into a society Probably an actual desire for company prompts them to do this as much as mutual advantage There is a strong case for giving rooks the credit for sympathy for they will often continue flying near one of their number who has been wounded or killed by a gun

partner condemned to live her life out in an uncongenial winter climate"

Mutual Aid

To go back to the wider subject of mutual aid in the Struggle for Existence, which includes a great deal that is not directly competitive at all, we could draw on a long list of examples to illustrate animal instinct for the welfare of their race "When we pass from the struggle for existence in its many forms to consider old-established activities which secure the welfare of the species, we arrive at a result which colours our whole view of Animate Nature, and is of great interest to philosophy—to that philosophy at least which has one hand on Human History and the other on Natural History, and is as a daysman between them Postponing the difficult question as to where we should draw the line which delimits set purpose, we find that a very large part of the time and energy of living creatures is given over to activities which do not make for self-increase or self-stability or self-preservation, but make for the welfare of the family, the kin, and the species

"To a degree which has not been adequately realised by naturalists, organisms are adapted to and give themselves up to securing the welfare of their race In their multiplication, in their reproductive processes, in their parental care individuals spend themselves in activities which are often not to their own advantage. Their personal interests have been subordinated to those of the species They are borne on by

impulses and instincts which are as compelling as hunger and thirst, but the satisfaction of these rarely makes for individual advantage Indeed, it is often fatal

"Animals have become organically interested in working for the species, and even though they know it not, their individuality completed itself in the larger life of their race What it seems to mean, according to current evolution theory, is that variations (probably altogether germinal to begin with) in directions which made for the welfare of offspring, family, society, or species, have been established in the course of selection no less securely than those which made for self-preservation Metaphorically speaking, we may say that this has been Nature's way of setting the seal of her approval on altruistic behaviour, even when the animal s left hand does not know what its right hand doeth" (*The System of Animate Nature*, by Sir J Arthur Thomson)

Mammals and birds are working in a common cause and for the general welfare of their kind when they hunt together or employ concerted means for self protection, form communities, and develop a social life Mutual aid often takes the form of combination and concerted action, thus alleviating the individual struggle for existence Individuals act together as a united body, it may be in hunting prey or in combining their efforts in self defence, or it may be in the performance of a piece of work or in some other common enterprise

There is sometimes co operation in hunting as in the case of pelicans, who combine in a crescent and, wading shorewards they narrow it and drive the fish before them, when they have got them cornered in the circle they fill their huge throat pouches It is said that a pair of golden eagles will occasionally hunt in concert, one beating the bushes while the other flies overhead, waiting to pounce Some small birds, as the meadow-wagtail, will combine in common action to chase a big bird of prey like a buzzard or a hawk A pack of wolves hunting together may overcome the strong courageous elk with its sharp hoofs and its formidable antlers whereas a single wolf would be hurled to the ground, a single rook could put up little defence against a hawk, but against a dozen rooks the aggressor would turn tail and fly off, or one weasel against a dog, but no one dog would venture against a company of weasels, an isolated monkey attacked by an eagle has no chance, but his cries bring a crowd of comrades to his aid, and they may tear the bird of prey to pieces It takes the combined action of bees to make a bee hive; and it is only by communal enterprise that beavers can dig a canal through an island in the middle of a river or build a dam

Mr W P Pycraft, in his *History of Birds*, says "Among gregarious species some display a much more intimate association than others—are more social in their relationships And this is shown very clearly in the devices which some species have adopted for their mutual protection during sleep The common partridge, as is well known, lives in small companies or 'coveys, which scatter only while feeding, and then not far enough to be beyond call Later in the day, as soon 'as the beetles begin to buzz,' says Professor Newton, the whole move away together to some spot where they jug, as it is called—that is, squat and nestle close together for the night, and from the appearance of the mutings, or droppings, which are generally deposited in a circle of only a few inches in diameter, it would appear that the birds arrange themselves also in a circle, of which their tails form the centre all the heads being outward—a disposition which instinct has suggested as the best for observing the approach of any of their numerous enemies, whatever may be the direction and thus increase their security by enabling them to avoid a surprise Ducks similarly take special pre cautions to secure safety during sleep, when this must be taken in exposed situations as when, for example, they desire to doze between the intervals of feeding during the night, which they pass afloat At such times they keep close together, and to avoid drifting ashore keep one leg slowly paddling and thus drive themselves round in circles"

This mutual protection is not confined to sleeping hours as is well known one of the important affairs of community in the world is protection from the danger of attack from animal foes or from human beings The posting of

[Photo : Keystone View Company

WOLVES INDULGING IN SPORT AT WHIPSNADE ZOO

Note the keenly interested expression of each individual wolf in what is taking place.

sentinels is common among a large variety of animals and birds. The zebra herds, like the antelopes, post a sentry when the herd is at its drinking place, which is often beset with enemies. Even the elephants have deliberate ways in posting sentries; a herd of monkeys has

[Photo H. Bastin

COMPANIONSHIP

Many birds seem to enjoy the companionship and friendship of other birds. The fact that this bullfinch and greenfinch were observed to seek each other out daily and always met in the same place seems to show that they liked each other's company; there was no other reason for their association.

its sentinels or outposts which warn the main body when danger draws near. With the baboons discipline is very rigid and nothing is allowed to distract a baboon from his duties. Parrots go one better than the monkeys when they go a-hunting. "They display the most wonderful intelligence, prudence, and capacity of coping with circumstances. Take, for instance, a band of white cockatoos in Australia. Before starting to plunder a cornfield they first send out a reconnoitring party, which occupies the highest trees in the vicinity of the field, while other scouts perch upon the intermediate trees between the field and the forest and transmit the signals. If the report runs 'All right,' a score of them will separate from the bulk of the band, take a flight in the air, and then fly towards the trees nearest to the field. They also will scrutinise the neighbourhood for a long while, and only then will they give the signal for general advance, after which the whole band starts at once and plunders the field in no time." (Kropotkin.)

Social Life

With birds, as with mammals, there are many phases of social life. Some species of birds are more social in their relationships than others; in some there is a more advanced state of community than others. Many birds, like human beings, would seem to enjoy the company of their kind. The gregarious habit is common, for example, among rooks, starlings, pigeons, and swallows; parrots roam in bands, apparently for the pleasure of one another's company.

[Photo B. S. Berridge

THE ALTRUISTIC CURLEW

Mr. W. H. Hudson says: The curlew is the unsleeping sentinel of all the wild creatures pursued by man, warning them of danger with piercing cries that none fail to understand; he is distressed if they fail to act on his signal. If this shrill cry fails to attract attention the curlew will swoop down and brush an unsuspecting creature with his wing.

Brehm, the celebrated naturalist, described the mode of life of the parrot thus: "Except in the pairing season, they live in very numerous societies or bands. They choose a place in the forest to stay there, and thence they start every morning for their hunting expeditions. The members of each band remain faithfully attached

FOX CUBS AT PLAY

Fox cubs are delightfully playful the mother fox watches them with a proud eye from a little distance and often joins in their gambols and fun

poses, but simply to enjoy life in *society and to* spend their time in plays and sports, after having given a few hours every day to find their daily food

We may have crowds and associations, however without sociability, a community of separate individuals may exist without there being any corporate life or power of acting as a unity Still, we do see many instances of a capacity *for unified action* and distinct features of a social life There appears *to be an in*tellectual advantage in sociability, if we may argue from *the fact that many social animals show a high* development of wits The three cleverest kinds of birds are rooks, cranes and parrots, and they are notably social There is, of course, the danger of putting the cart before the horse, for it may be that the sociability is in part the expression of good brains It may also be argued that the non gregarious crow is just as clever as the social rook, and many analogous instances might be given ' (Thomson s *The Wonder of Life*)

to each other, and they share in common good or bad luck All together they repair in the morning to a field, or to a garden, or to a tree, to feed upon fruits They post sentries to keep watch over the safety of the whole band, and are attentive to their warnings In case of danger, all take to flight, mutually supporting each other, and all simultaneously return to their resting place In a word, they always live closely united

There seems little reason to doubt that among many birds social life is practised at the nesting period not only for security but chiefly for the pleasure derived from it In fact, naturalists tell us, it would be easier to describe the species which live alone by themselves than to name those species which join the autumnal societies of young birds—not for hunting or nesting pur-

§ 3

IN the same impressionistic way we turn to one other phase in the lives of bird and beast which we cannot fail to see plainly before our eyes Man's life is not altogether a thing of struggle for physical well being, of competition, daily

It has somehow been of advantage, direct or indirect, to birds to acquire a greater capacity for affection, for jealousy, for joy, for fear, for curiosity. In birds the advance on the intellectual side has been less, on the emotional side greater, so that we can study in them a part of the single stream of life where emotion untrammelled by much reason has the upper hand.* He is a dull biologist who would attempt to describe the bird mind wholly in terms of knowledge of emotion or any other conscious process in the life of any human being save our individual selves, and yet we feel no hesitation in deducing it from others' behaviour. Although it is an arguable point whether biological science may not for the moment be better served by confining the subject matter and terms of analysis to behaviour alone, it is a very foolhardy "behaviourist" indeed who denies the *existence* of emotion and conscious process.

MOTHER TIGER AND CUBS AT PLAY [*Sport and General*

Games and play form an important part in the life of young animals and no doubt serve to prepare them for their life of struggle. Nevertheless animals do play for the sake of playing, and that long after their youth is past.

automatic mechanistic behaviour. In his *Essay on Bird Mind* Professor Julian Huxley expresses a view held by other biologists besides himself.

The objection is easily and often raised that we have no direct knowledge of emotion in an animal, no direct proof of the existence of any purely mental process in its life. But this is as easily laid as raised. We have no direct know-

* *Essays of a Biologist.* By Julian S. Huxley (Chatto & Windus).

I for one maintain that to omit a whole category of phenomena from consideration is unscientific, and must in the long run lead to an unreal, because limited, view of things; and that when great detail of analysis *is not required*, but only broad lines and general comparison, the psychological terminology, of memory, fear, anger, curiosity, affection, is the simpler and more direct tool, and should be used to supplement and make more real the cumbersome and less

complete behaviouristic terminology, of modification of behaviour, fright, aggression, and the rest

"It is at least abundantly clear that, if we are to believe in the principle of uniformity at all, we must ascribe emotion to animals as well as to men the similarity of behaviour is so great that to assert the absence of a whole class of phenomena in one case, its presence in the other, is to make scientific reasoning a farce" *

All we seek to illustrate here, as in previous pages of this chapter, is a particular phase of animal life which we can all see with our own eyes We are speaking now of a phase of animal life where the chief thing we note is the joy of living and the capacity for emotional feeling

Biologists have closely analysed and discussed the part which games and play serve in the life of young animals as a preparation or apprenticeship for the subsequent business of life The natural instinct for such games is inborn and bears a definite relation to the future life of beast and bird But there are some "unruly facts" to face before it can be affirmed that that is the sum total of this aspect of animal behaviour Some animals can be seen playing, and playing with gusto, long after youth is past, manifestly playing for the pleasure of it

After making all allowances for the biological significance of animal play, especially in the young—its utility and value for educating powers which are useful in after life, and so on—there remains the fact that there is something over and above that Apart from the utilitarian or schooling purposes, it is clear that some mammals and some birds play for the love of playing While we see them running after each other, one trying to capture another, wrestling and tussling, gambolling or teasing each other, and experimenting, we see a behaviour with the utilitarian purpose behind it, and interpret it as a kind of apprenticeship for the animal's subsequent business of life But we cannot read any such thing into the communal playing to take one example, of full grown penguins, which is a manifestation of true sociability, like the group dancing and singing of some species of birds, and other exhibitions of *joie de vivre*

* *Essays of a Biologist* By Julian S Huxley

Apart, as we have said, from all the utilitarian purposes of play and sport there are manifestations of instinctive activities which are a source of pleasure, the love of the thing for itself, the human like striving for supremacy, and the satisfaction of excelling Huxley mentions the entertaining flying sports, or games, of the herring-gull, the raven, the egret, etc "Rooks and crows, our solemn English heron, curlew, swift, snipe—these and many others have their own peculiar flying sports What is clear to the watcher is the emotional basis of these sports—a joy in controlled performance, an excitement in rapidity of motion, in all essentials like the *pleasure to us of a well hit ball at golf or the* thrill of a rapid descent on sledge or skis" How often on our lips, as we watch certain behaviour and antics of some birds and other creatures, are the words, "how human!"

Almost human like, too, in their fraternal groupings and in their individual jealousies and antipathies, friendships and hatreds, attraction and repulsion, in a word, in their individual temperament

The Emotional Life

We witness the emotional life of birds at its height in their singing, the sensation, as Jacques Delmain says in his book *Why Birds Sing*, "of well being joy of existence, happiness at feeling in his place in a chosen corner of nature, at holding his territory in the face of rival covetousness, desire and possession of his mate Musical art is born of the satisfaction which a being experiences in expressing his life by a sound A bird enjoys the note modulated by his own throat But if he attains art it is because, endowed with a sense of the beautiful, he is able to choose among his notes the clearest, the purest, and the fullest, to link one to another, to find the rhythm, compose the phrase, transpose the tune, thus achieve pure music, and make a song gush out from a cry And it is in his search for beauty that the art of the bird touches us We comprehend and interpret his æsthetic effort The Lark's song becomes for us the expression of courageous and serene cheer, in the stanzas of the Nightingale we find an accent of fervour The Skylark varies his combina

discussing the complicated subject of sexual selection. That is a different matter.

The habit of dancing, Mr. Hudson declares, is much more widely spread than was formerly believed, and he gives in his master work, *The Naturalist in La Plata*, some exceedingly interesting particulars of complicated dances of a number of different birds whose performances he witnessed; among the dances of the rails, jacanas, lapwings, etc. The following description has been often quoted:

"A stranger performance is that of the spur-winged lapwing of the same region—a species resembling the lapwing of Europe, but a third larger, brighter coloured, and armed with spurs. The lapwing display, called by the natives its 'dance,' or 'serious dance'—by which they mean square dance—requires three birds for its performance, and is, so far as I know, unique in this respect. The birds are so fond of it that they indulge in it all the year round, and at frequent intervals during the day, also on moonlight nights. If a person watches any two birds for some time—for they live in pairs—he will see another lapwing, one of a neighbouring couple, rise up and fly to them, leaving his own mate to guard their chosen ground; and instead of resenting this visit as an unwarranted intrusion on their domain, as they would certainly resent the approach of almost any other bird, they welcome it with notes and signs of pleasure Advancing to the visitor, they place themselves behind it; then all three, keeping step, begin a rapid march, uttering resonant drumming notes in time with their movements; the notes of the pair behind being emitted in a stream, like a drum-roll, while the leader utters loud single notes at regular intervals. The march ceases; the leader elevates his wings and stands erect and motionless, still uttering loud notes; while the other two, with puffed-out plumage and standing exactly abreast, stoop forward and downward until the tips of their beaks touch the ground, and, sinking their rhythmical voices to a murmur, remain for some time in this posture The performance is then over and the visitor goes back to his own ground and mate, to receive a visitor himself later on."

In all this display of vital plenitude, in song and dance, in chorus, sociability and æsthetic appreciation, can we think of the bird as a "mere machine" or living automaton with nothing but a fixed inherited organisation? There is an inner constitution, and a conscious process. An explanation of a mechanistic organism of nerve-cells, muscle cells, brain cells and physiological efficiency, bodily ingrained impulses that act like sparking plugs to start feeling, willing, and every kind of emotional behaviour is not enough. As Thomson says, 'all that by itself does not convincingly explain the curiosity of the jay and the jackdaw, or the trait of adventure we see in many birds, or the bower bird's fondness for beauty enjoyed, it is supposed, for its own sake. One cannot explain the lavish, elaborate, painstaking adornment and the refined taste of its bower, a playground quite apart from its nest, by merely linking it on to love-making. For here, as elsewhere in bird-life, we have appreciation of things beautiful, or so it seems, a hint of the beginning of our own delight and joy in the beautiful.'

We speak of instinct, not knowing all that is behind instinct, that inborn gift which has such variety in insect, bird, and beast. We are driven to believe that emotional behaviour is one of the primary qualities of the bird-mind, and that it is capable of an æsthetic thrill that is more than the simple display of a mere automatic mechanistic organism It belongs to the nature of the bird-mind itself

> As each a separate individual thing,
> Which only learns to act, or move, or sing
> In ways that wholly to itself belong

That the social instinct is characteristic of birds and most other living creatures is plain; there is the evident desire to communicate in some way or another with their fellow creatures, with individuals of their own or other species; it seems a necessity of their being. We may not know all their ways of communicating impressions, which is not confined to the chattering of birds, to companionship, and the coming together for more strictly sociable life. There is a ring of truth in the words of a naturalist who

says · "The necessity of simply feeling the proximity of other kindred living beings pervades Nature, and is, as much as any other physiological function, *a distinctive feature of life and impressionability*"

The Contrast

Recalling the various phases of animal life which have been sketched in the foregoing pages, we see in their totality some kind of resemblance to the lives of human beings A far-off resemblance, perhaps No strict genuine comparison is possible Man is endowed with reason, animals are not Man and animal live out their lives on different planes But the fact of solidarity is not a thing that we can now overlook We are *part of the one same stream of life* Man and animal, from a common ancestry, have evolved until we see them now, as they are, in their several gradations Man like the lower animals, has still to "struggle" for existence, aided by an imperfect reasoning faculty, which is practically absent in all the lower creation There we can discern only instinct and intelligence, and it is often impossible to draw any hard and fast line between them

In this drama of life which we have been picturing in the animal world we have not been seeking philosophic conclusions, but simply, in a pictorial way, trying to present (without importing human sentiments) the drama in its totality, a balancing of one thing against another No one can explain the inwardness of it, or the ultimate end to be served, which there must be if we believe that there is purpose *behind* creation No philosopher in the world has solved the problem of suffering, which, as one of them remarks, 'came into the world millions of years before mankind' *For the present*, then, we have put philosophy aside, except in so far as we can read into it the scientific thought of the keen observers of nature We have seen a little of that as we have gone along The behaviour of all animate life is a conditioned behaviour, conditioned by environment, and by the nature of its being, and of stern necessity As a naturalist-biologist puts it, "in satisfying the imperious primal impulses the organism encounters obstacles, and the inmost secret of life, from first to last, is endeavour" If there is an end to be attained, it is to be attained through endeavour In the foregoing pages we have given some illustrations of a few of the forms of endeavour that we can see for ourselves in the normal life of birds and beasts from the elemental struggle for food and foothold and self-preservation, to the higher forms of endeavour where bird and beast seek to express the inner or emotional side of their being, and seek, too, to further the increasing well being of their race

In a passage where he is referring to the general level of animal life, Professor Whitehead writes in his most recent book, *Adventures of Ideas* (Cambridge Press), "At this low animal level, flashes of æsthetic insight, of technological attainment, of sociological organisation, of affectionate feeling display themselves Nightingales, beavers, ants, the kindly nurture of the young, all witness to the existence of this level of life in the animal world Of course, all these modes of functioning are carried to an immeasurably higher level among mankind In human beings these various modes of functioning exhibit more variety of adaptation to special circumstances, but they are more complex and they are more interwoven with each other But without question, among animals they are there, plainly demonstrated to our observation" Now we may turn to consider some philosophical aspects of nature

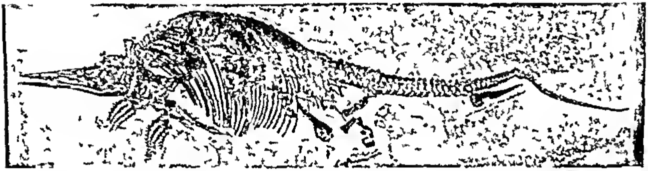
(*To be continued on page 389*)

BOOK II—(*Continued from page 304*)

MODERN SCIENCE

CHAPTER VII—(*Continued*)

THE STORY OF EVOLUTION—(*Continued*)



FOSSIL OF AN ICHTHYOSAUR [Elliott Hawks

There was a great diversity among the ancient reptiles The Ichthyosaur, probably the ancestor of the whale of to day was one of the earliest marine reptiles It belonged to a series of vertebrate, mammal like reptiles common in the Permian period Many of these successfully bridged the gulf between an amphibian and a land existence The Ichthyosaur and its like failed to adapt themselves to life on dry land and went back to the sea The almost perfect fossil shown above is one of many found in Great Britain showing that the Ichthyosaur was an inhabitant of the sea that once covered this country

§ 1

REPTILES APPEAR

IN the *Permian* period reptiles appeared, or perhaps one should say, began to assert themselves That is to say, there was an emergence of backboned animals which were free from water and relinquished the method of breathing by gills, which Amphibians retained in their young stages at least The unhatched or unborn reptile breathes by means of a vascular hood spread underneath the egg shell and absorbing dry air from without It is an interesting point that this vascular hood, called the allantois, is represented in the Amphibians by an unimportant bladder growing out from the hind end of the food canal A great step in evolution was implied in the origin of this antenatal hood or fœtal membrane and another one—of protective significance—called the amnion, which forms a water bag over the delicate embryo The step meant total emancipation from the water and from gill breathing, and the two fœtal membranes, the amnion and the allantois, persist not only in all reptiles but in birds and mammals as well

It is a suggestive fact that the embryos of all reptiles, birds, and mammals show gill clefts—*a tell tale evidence of their distant aquatic ancestry* But these embryonic gill clefts are not used for respiration and show no trace of gills except in a few *embryonic* reptiles and birds, where their dwindled vestiges have been recently discovered As to the gill clefts, they are of no use in higher Vertebrates except that the first becomes the Eustachian tube leading from the ear-passage to the back of the mouth The reason why they persist when only one is of any use, and that in a transformed guise, would be difficult to interpret except in terms of the Evolution theory. They illustrate the lingering influence of a long pedigree, the living hand of the past, the tendency that individual development has to recapitulate racial evolution In a condensed and telescoped

A PROGRESSIVE CONQUEST

§ 2

SO far we have arrived at the time when the first land animals and the first Amphibians have all come on the scene. The sublime process of evolution has implied a mastery of all the possible haunts of life. It has been a progressive conquest of environment. Let us see the significance of it.

It is highly probable, as we have said, that living organisms found their first foothold in the stimulating conditions of the shore of the sea—shallow water, brightly illumined, of the seaweed-growing shelf fringing the Continents. This littoral zone was a propitious environment, where sea and fresh water, earth and air all meet, where there is stimulating change, abundant oxygenation, and copious supply of nutritive material in what the streams bring down and in the rich seaweed vegetation.

It is not an easy haunt of life, but none the worse for that, and it is tenanted to-day by representatives of practically every class of animals, from infusorians to sea-shore birds and mammals.

The open sea or pelagic haunt includes all the brightly illumined surface waters beyond the shallow water of the shore area. It is perhaps the easiest of all the haunts of life, for there is no crowding, there is considerable uniformity, and an abundance of food for animals is afforded by the inexhaustible floating "sea meadows" of microscopic algæ. These are reincarnated in minute animals like the open-sea crustaceans, which again are utilised by fishes, these in turn making life possible for higher forms like carnivorous turtles and toothed whales. It is quite possible that the open sea was the original cradle of life, and perhaps Professor Church is right in picturing a long period of pelagic life before there was any sufficiently shallow water to allow the floating plants to anchor. It is rather in favour of this view that many shore animals, such as crabs and starfishes, spend their youthful stages in the relatively safe cradle of the open sea, and only return to the more strenuous conditions of their birthplace after they have gained considerable strength of body. It is probably safe to say that the honour of being the original cradle of life lies between the shore of the sea and the open sea.

The Great Deeps

A third haunt of life is the floor of the Deep Sea, the abysmal area which occupies more than a half of the surface of the globe. It is a region of extreme cold—an eternal winter; of utter darkness—an eternal night—relieved only by the fitful gleams of "phosphorescent" animals; of enormous pressure—2½ tons on the square inch at a depth of 2,500 fathoms; of profound calm, unbroken silence, immense monotony. And as there are no plants in the great abysses, the animals must live on one another, and, in the long run, on the rain of moribund animalcules which sink from the surface through the miles of water. It seems a very unpromising haunt of life, but it is abundantly tenanted, and it gives us a glimpse of the insurgent nature of the living creature that the difficulties of the Deep Sea should have been so effectively conquered. It is probable that the colonising of the great abysses took place in relatively recent times, for the fauna does not include many very antique types. It is practically certain that the colonisation was due to littoral animals which followed the food debris, millennium after millennium, further and further down the long slope from the shore.

A fourth haunt of life is that of the freshwaters, including river and lake, pond and pool, swamp and marsh. It may have been colonised by gradual migration up estuaries and rivers, or by more direct passage from the seashore into the brackish swamp. Or it may have been in some cases that landlocked corners of ancient seas became gradually turned into freshwater basins. The animal population of the freshwaters is very representative, and is diversely adapted to meet the characteristic contingencies—the risk of being dried up, the risk of being frozen hard in winter, and the risk of being left high and dry after floods, or of being swept down to the sea.

Co rtesy of The Illustrated London News]

A VARIETY OF EARLY REPTILES AND THE

The illustration shows the variable forms of reptilian life in the Permian period when there was a great emergence their surround ngs have been reconstructed from fossil evidences found on the bed of the Ind an Ocean where ma Africa Ind a and Australia The vegetation of this vast swampy area was rich in such plants as horse tails rush Dinosaurs of the *Triassic* period

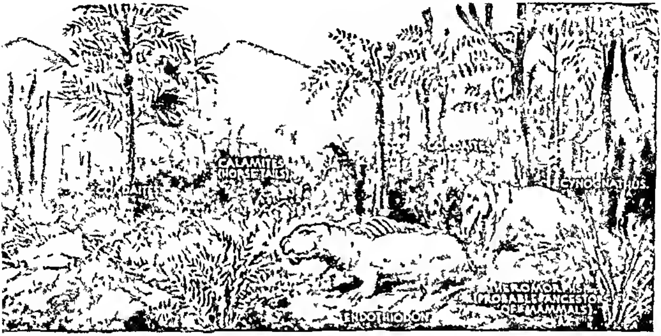
Conquest of the Land

The terrestrial haunt has been invaded age after age by contingents from the sea or from the freshwaters We must recognise the worm invasion, which led eventually to the making of the fertile soil, the invasion due to air breathing Arthropods which led eventually to the important linkage between flowers and their insect visitors, and the invasion due to air breathing Amphibians, which led eventually to the higher terrestrial animals and to the development of intelligence and family affection Besides these three great invasions, there were minor ones, such as that leading to land snails, for there has been a widespread and persistent tendency among aquatic animals to try to possess the dry land

Getting on to dry land had a manifold significance

It implied getting into a medium with a much larger supply of oxygen than there is dissolved in the water But the oxygen of the air is more difficult to capture especially when the skin becomes hard or well protected, as it is almost bound to become in animals living on dry ground Thus this leads to the development of *internal surfaces*, such as those of lungs, where the oxygen taken into the body may be absorbed by the blood In most animals the blood goes to the surface of oxygen capture, but in insects and their relatives there is a different idea—of taking the air to the blood or in greater part to the area of oxygen combustion the living tissues A system of branching air-tubes takes air into every hole and corner of the insect s body, and this thorough aeration is doubtless in part the secret of the insect s intense activity The blood never becomes impure

The conquest of the dry land also implied a predominance of that kind of locomotion which may be compared to punting when the body is pushed along by pressing a lever against a hard substratum And it also followed that with *few exceptions the body of the terrestrial animal* tended to be compact, readily lifted off the ground by the limbs or adjusted in some other way so that there may not be too large a surface trailing on the ground An animal like a jelly fish easily supported in the water, would be impossible on land Such apparent exceptions



[Drawing by D Macpherson under the permission of Prof J Stanley Gardiner F R S

SURROUNDINGS IN THE PERMIAN PERIOD

animals who had successfully adapted themselves to a terrestrial or semi terrestrial existence The reptiles and
f years ago the now submerged continent of Gondwanaland was joined to the continents of South America
l cycads Many of these early reptiles became extinct but their race was continued on in the Plesiosaurs and

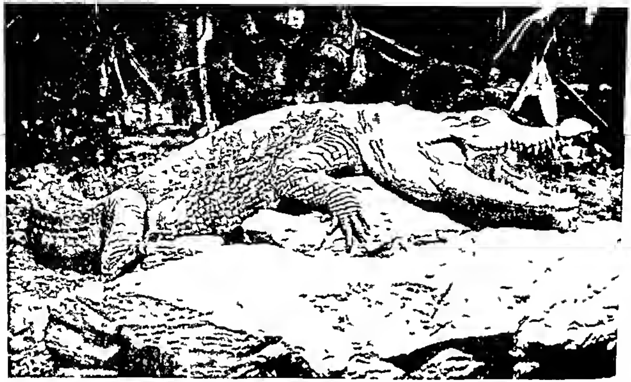
as earthworms, centipedes, and snakes are not difficult to explain, for the earthworm is a burrower which eats its way through the soil, the centipede's long body is supported by numerous hard legs, and the snake pushes itself along by means of the large ventral scales to which the lower ends of very numerous ribs are attached

Methods of Mastering the Difficulties of Terrestrial Life

A great restriction attendant on the invasion of the dry land is that locomotion becomes limited to one plane, namely, the surface of the earth This is in great contrast to what is true in the water, where the animal can move up or down to right or to left, at any angle and in three dimensions It surely follows from this that the movements of land animals must be rapid and precise, unless, indeed, safety is secured in some other way Hence it is easy to understand why most land animals have very finely developed striped muscles, and why a beetle running on the ground has far more numerous muscles than a lobster swimming in the sea

Land animals were also handicapped by the risks of drought and of frost, but these were met by defences of the most diverse description, from the hairs of woolly caterpillars to the fur of mammals, from the carapace of tortoises to the armour of armadillos In other cases, it is hardly necessary to say, the difficulties may be met in other ways, as frogs meet the winter by falling into a lethargic state in some secluded retreat

Another consequence of getting on to dry land is that the eggs or young can no longer be set free anyhow, as is possible when the animal is surrounded by water, which is in itself more or less of a cradle If the eggs were laid or the young liberated on dry ground, the chances are many that they would be dried up or devoured So there are numerous ways in which land animals secure the safety of their young, e g by burying them in the ground, or by hiding them in nests, or by carrying them about for a prolonged period either before or after birth This may mean great safety for the young, this may make it possible to have only a small family, and this may tend to the evolution of parental



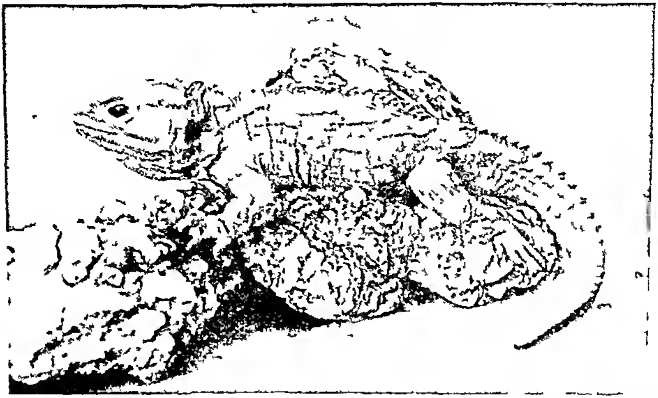
[Photo Fox

CROCODILE A DIRECT DESCENDANT OF THE ANCIENT REPTILES

Some of the early reptiles are continued in a modified form in the crocodiles and lizards of to day They have become admirably fitted for an aquatic life Mr E G Boulenger says of the crocodile It will be observed that apart from possessing webbed feet and a compressed tail adapted for propulsion in the water, its eyes nostrils and ears are all situated on the top of the head enabling these parts to function when the animal is floating aimlessly about with only the head exposed Further it may be noted that the nostrils and ears are furnished with movable valves which close when the reptile sinks below the surface thus preventing the inflow of the water The eyes in addition to a pair of eyelids are protected by transparent discs whilst the tongue is so constructed that it forms a valve and prevents water from rushing down the throat when the mouth is opened

and sometimes but slightly changed The lamp shell, *Lingulella*, of the Cambrian and Ordovician period has a very near relative in the *Lingula* of to day There are a few extremely conservative animals (*b*) There are ancient types which have no living representatives, except in the guise of transformed descendants, as the king crab (*Limulus*) may be said to be a transformed descendant of the otherwise quite extinct race to which Eurypterids or sea scorpions belonged (*c*) There are altogether extinct types—*lost races*—which have left not a wrack behind For there is not any representation to day of such races as Graptolites and Trilobites

Looking backwards over the many millions of years comprised in the Palæozoic era what may we emphasise as the most salient features? There was in the *Cambrian* the establishment of the chief classes of backboneless animals, in the *Ordovician* the first fishes and perhaps the first terrestrial plants, in the *Silurian* the emergence of air breathing Invertebrates and mud fishes, in the *Devonian* the appearance of the first Amphibians, from which all higher land animals are descended and the establishment of a land flora, in the *Carboniferous* the great club moss forests and an exuberance of air breathing insects and their allies, in the *Permian* the first reptiles and a new flora



[Photo F W Bond

A REMARKABLE SURVIVAL

The Sphenodon or "Tuatera" as it is called by the Maoris on account of its spiny back is the sole living representative of an ancient order of reptiles from which tortoises and lizards have arisen The Tuatera is the same to day as it was millions of years ago Beneath the skin upon the top of its head there are rudiments of the pineal or "third" eye which was once a functional organ The Tuatera is nocturnal in habits and passes the daytime asleep in an underground burrow which it excavates in the soil with its powerful claws

The Permian period marks the late Palæozoic era an era which is estimated to have lasted many millions of years The rise of the various creatures we have mentioned and the evolution story, so far as we have got, is short enough reckoned in terms of the earth's age, but long enough to bewilder our imagination

We now arrive at what are called the geological middle ages We come to the Mesozoic era At the end of the previous era (the Palæozoic) the reptiles had come on the scene They are now dominant

THE GEOLOGICAL MIDDLE AGES

§ 3

The Mesozoic Era

IN a broad way the Mesozoic era corresponds with the *Golden Age of reptiles*, and with the climax of the Conifer and Cycad flora which was established in the Permian But among the Conifers and Cycads our modern flowering plants were beginning to show face tentatively, just like birds and mammals among the great reptiles

In the *Triassic* period the exuberance of reptilian life which marked the Permian was continued Besides Turtles, which still persist, there were Ichthyosaurs, Plesiosaurs, Dinosaurs, and Pterosaurs, none of which lasted beyond the Mesozoic era Of great importance was the rise of the Dinosaurs in the Triassic, for it is highly probable that within the limits of this vigorous and plastic stock—some of them bipeds—we must look for the ancestors of both birds and mammals Both land and water were dominated by reptiles, some of which attained to gigantic size Had there been any zoologist in those days, he would have been very sagacious indeed if he had suspected that reptiles did not represent the climax of creation

The Flying Dragons

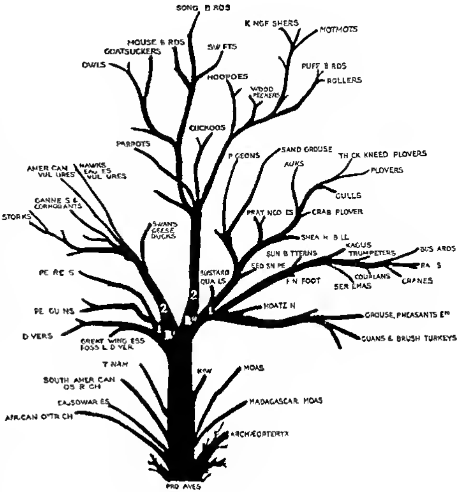
The *Jurassic* period showed a continuance of the reptilian splendour They radiated in many directions, becoming adapted to many haunts Thus there were many Flying Lizards paddling in the seas, many types of terrestrial dragons stalking about on land, many swiftly gliding aligator-like forms, and the Flying Dragons which began in the Triassic attained to remarkable success and variety Their wing was formed by the extension of a great fold of skin on the enormously elongated outermost finger, and they varied from the size of a sparrow to a spread of over five feet A soldering of the dorsal vertebræ, as in our Flying Birds, was an adaptation to striking the air with some force, but as there is not more than a slight keel, if any, on the breast-bone, it is unlikely that they could fly far. For we know from our modern birds that the power of flight may be to some extent gauged from the degree of development of the keel, which is simply a great ridge for the better insertion of the muscles of flight It is absent, of course, in the Running Birds, like the ostrich, and it has degenerated in an interesting way in the burrowing parrot (*Stringops*) and a few other birds that have " gone back "

The First Known Bird

But the Jurassic is particularly memorable because its strata have yielded two fine specimens of the first known bird, *Archæopteryx* These were entombed in the deposits which formed the fine-grained lithographic stones of Bavaria, and practically every bone in the body is preserved except the breast-bone Even the feathers have left their marks with distinctness This oldest known bird—too far advanced to be the first bird—was about the size of a crow and was probably of arboreal habits Of great interest are its reptilian features, so pronounced that one cannot evade the evolutionist suggestion It had teeth in both jaws, which no modern bird has, it had a long lizard like tail, which no modern bird has, it had claws on three fingers, and a sort of half made wing That is to say, it does not show, what all modern birds show, a fusion of half the wrist bones with the whole of the palm bones, the well known carpo metacarpus bone which forms a basis for the longest pinions In many reptiles, such as crocodiles, there are peculiar bones running across the abdomen beneath the skin, the so called " abdominal ribs," and it seems an eloquent detail to find these represented in *Archæopteryx*, the earliest known bird No modern bird shows any trace of them

There is no warrant for supposing that the flying reptiles, or Pterodactyls, gave rise to birds, for the two groups are on different lines, and the structure of the wings is entirely different Thus the long fingered Pterodactyl wing was a parachute wing, while the secret of the bird's wing has its centre in the feathers It is highly probable that birds evolved from certain

Dinosaurs which had become bipeds, and it is possible that they were for a time swift runners that took "flying jumps" along the ground. Thereafter, perhaps, came a period of arboreal apprenticeship during which there was much gliding from tree to tree before true flight was achieved. It is an interesting fact that the problem of flight has been solved four times among animals—by insects, by Pterodactyls, by birds, and by bats, and that the four solutions are on entirely different lines.



THE EVOLUTION OF BIRDS

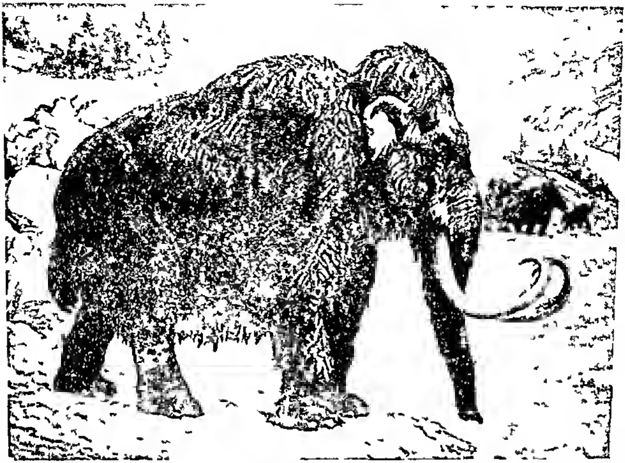
It is highly probable that birds evolved from certain Dinosaurs which had become bipeds and it is possible that they were for a long time swift runners that took "flying jumps" along the ground. Thereafter perhaps *came a period of aboreal apprenticeship during which there was much* gliding from tree to tree before true flight was achieved. The above is a *diagrammatic attempt to* express the relationship of the main group of present day birds based on their structural affinities. The main stock is shown as arising from the ancestral "Pro Aves" after the ancient reptiles. Offshoots low down represent the extinct Archæopteryx (but see p 355) and the different ostrich like birds present and recent. Higher up two main branches B' B" are shown each of them dividing again into two (1 2 1 2) and then into the twigs representing the various groups.

Conquering the Air

A mastery of the air must be placed to the credit of insects, Pterodactyls, birds, and bats. These have been the successes, but it should be noted that there have been many brilliant failures, which have not attained to much more than parachuting. These include the Flying Fishes, which take leaps from the water and are carried for many yards and to considerable heights holding their enlarged pectoral fins taut or with little more than a slight fluttering. There is a so called Flying Frog (*Rhacophorus*), that skims from branch to branch, and the much more effective Flying Dragon (*Draco volans*) of the Far East, which has been mentioned already. Among mammals there are Flying Phalangers, Flying Lemurs, and more besides, all attaining to great skill as parachutists, and illustrating the endeavour to master the air which man has realised in a way of his own.

The Power of Flight

The power of flight brings obvious advantages. A bird feeding on the ground is able to evade the stalking carnivore by suddenly rising into the air, food and water can be followed rapidly and to great distances, the eggs or the young can be placed in safe situations, and birds in their migrations have made a brilliant conquest both of time and space. Many of them know no winter in their year, and the migratory flight of the Pacific Golden Plover, from Hawaii



THE MAMMOTH *[James's Press*

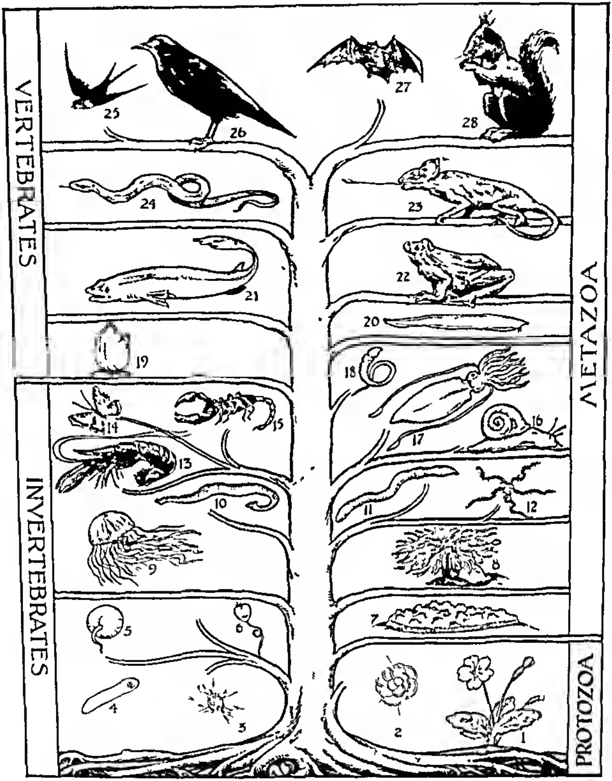
During the Pleistocene age vast geographical and climate changes took place. Many of the larger mammals such as the Mammoth and the woolly Rhinoceros which had become adapted to a cold climate were forced by successive interglacial (warmer) periods to retreat farther and farther north. As the ice receded their chance of survival lessened and finally they became extinct. The Mammoth was hunted by late Palæolithic man who left drawings of the animal in caves.

§ 5

THE *Pliocene* period was a more strenuous time, with less genial climatic conditions and with more intense competition. Old land bridges were broken and new ones made and the geographical distribution underwent great changes. Professor R. S. Lull describes the *Pliocene* as "a period of great unrest. . . . Many migrations occurred the world over, new competitions arose, and the weaker stocks began to show the effects of the strenuous life. One momentous event seems to have occurred in the Pliocene and that was the transformation of the precursor of humanity into man—the culmination of the highest line of evolution."

The *Pleistocene* period was a time of sifting. There was a continued elevation of the continental masses and Ice Ages set in, relieved by less severe interglacial times when the ice sheets retreated northwards for a time. Many types like the mammoth, the woolly rhinoceros, the sabre toothed tiger, the cave lion, and the cave bear became extinct. Others which formerly had a wide range became restricted to the Far North or were left isolated here and there on the high mountains, like the Snow Mouse, which now occurs on isolated Alpine heights above the snow line. Perhaps it was during this period that many birds of the Northern Hemisphere learned to evade the winter by the sublime device of migration.

Looking backwards we may quote Professor Schuchert again: "The lands in the Cenozoic



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[To face page 356

FOUR KINDS OF FLYING

The problem of flight has been approached by animals in various ways, and the solutions are on entirely different lines The gull, at the top of the picture, may be said to have achieved the most complete mastery of the air His feather wing makes him a true flier The fox bat, with his wing of skin illustrates another form of limited yet nevertheless true flying ability The Flying Squirrel has a parachute of skin which enables it to swoop from tree to tree, but it is not a true flier Another form of aerial motion is achieved by the Flying Fish, which has pectoral fins enabling it to "vol-plane" or sail through the air in albatross fashion

to Alaska and back again, does not stand alone

In the *Cretaceous* period the outstanding events included the waning of giant reptiles, the modernising of the flowering plants, and the multiplication of small mammals Some of the Permian reptiles, such as the dog-toothed Cynodonts, were extraordinarily mammal like, and it was probably from among them that definite mammals emerged in the Triassic Comparatively little is known of the early Triassic mammals save that their back teeth were marked by numerous tubercles on the crown, but they were gaining strength in the late Triassic when small arboreal insectivores, not very distant from the modern tree-shrews (*Tupaia*), began to branch out in many directions indicative of the great divisions of modern mammals, such as the clawed mammals, hoofed mammals and the race of monkeys or Primates In the Upper Cretaceous there was an exuberant 'radiation' of mammals adaptive to the conquest of all sorts of haunts, and this was vigorously continued in Tertiary times

There is no difficulty in the fact that the earliest remains of definite mammals in the Triassic precede the first known bird in the Jurassic For although we usually rank mammals as higher than birds (being mammals ourselves, how could we do otherwise?), there are many ways in which birds are pre eminent, *e g* in skeleton, musculature, integumentary structures, and respiratory system The fact is that birds and mammals are on two quite different tacks of evolution, not related to one another, save in having a common ancestry in extinct reptiles Moreover, there is no reason to believe that the Jurassic *Archæopteryx* was the first bird in any sense except that it is the first of which we have any record In any case it is safe to say that birds came to their own before mammals did

Looking backwards, we may perhaps sum up what is most essential in the Mesozoic era in Professor Schuchert's sentence "The Mesozoic is the age of reptiles, and yet the little mammals and the toothed birds are storing up intelligence and strength to replace the reptiles when the

cycads and conifers shall give way to the higher flowering plants"

§ 4

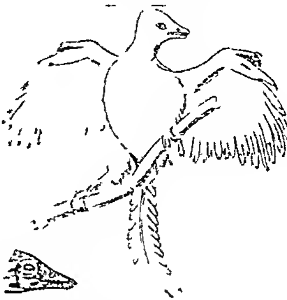
THE CENOZOIC OR TERTIARY ERA

IN the *Eocene* period there was a replacement of the small brained archaic mammals by big brained modernised types, and with this must be associated the covering of the earth with a garment of grass and dry pasture Marshes were replaced by meadows and browsing by grazing mammals In the spreading meadows an opportunity was also offered for a richer evolution of insects and birds

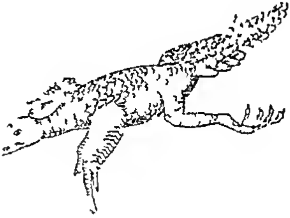
During the *Oligocene* the elevation of the land continued, the climate became much less moist, and the grazing herds extended their range

The *Miocene* was the mammalian Golden Age, and there were crowning examples of what Osborn calls ' adaptive radiation " That is to say, mammals, like the reptiles before them conquer every haunt of life There are flying bats, volplaning parachutists climbers in trees like sloths and squirrels quickly moving hoofed mammals, burrowers like the moles freshwater mammals, like duckmole and beaver shore frequenting seals and manatees, and open sea cetaceans some of which dive far more than full fathoms five It is important to realise the perennial tendency of animals to conquer every corner and to fill every niche of opportunity, and to notice that this has been done by successive sets of animals in succeeding ages *Most notably the mammals repeat all the experiments of reptiles on a higher turn of the spiral* Thus arises what is called convergence, the superficial resemblance of unrelated types, like whales and fishes the resemblance being due to the fact that the different types are similarly adapted to similar conditions of life Professor H F Osborn points out that mammals may seek any one of the twelve different habitat zones and that in each of these there may be six quite different kinds of food Living creatures penetrate everywhere like the overflowing waters of a great river in flood

THE FIRST BIRD AND ITS PROBABLE ANCESTOR



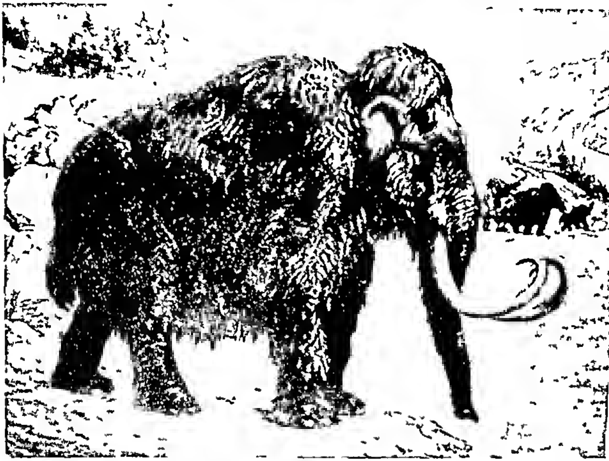
ARCHÆOPTERYX



PRO AVIAN

Birds and mammals are on two quite different tacks of evolution not related to one another saving in having a common ancestry in extinct reptiles The top illustration shows the Jurassic Archæopteryx the earliest known bird of which we have any record W P Pycraft whose restoration has been widely accepted says Archæopteryx is an indubitable bird in all but its teeth and the long lizard like tail One of its most significant features is seen in the free finger tip armed with a claw which projects beyond the outermost flight feather a feature which persists in the Amazonian Hoatzin of to day Below is Mr Pycraft s conception of the probable ancestor of Archæopteryx the primitive pro avian

That birds derive their power of flight from an *arboreal* and not from a *terrestrial* ancestor seems to be a conclusion from which there is no escape when all the facts are taken into consideration



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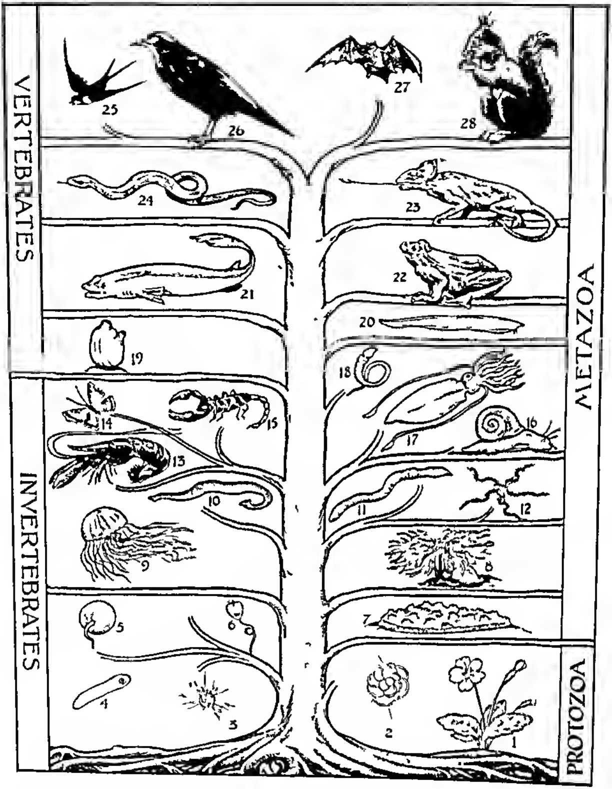

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[To face page 356

begin to bloom with more and more flowering plants and grand hardwood forests, the atmosphere is scented with sweet odours, a vast crowd of new kinds of insects appear, and the places of the once dominant reptiles of the lands and seas are taken by the mammals. Out of these struggles there rises a greater intelligence, seen in nearly all of the mammal stocks, but particularly in one, the monkey-ape-man line. Brute man appears on the scene with the introduction of the last glacial climate, a most trying time for all things endowed with life, and finally there results the dominance of reasoning man over all his brute associates." In man and human society the story of evolution has its climax.

We shall have more to say presently about the evolution of man. Meanwhile let us pause here to look back and consider some of the great steps in evolution.

GREAT STEPS IN EVOLUTION

In the dim and distant past there was a time when the only animals were of the nature of Protozoa, and it is safe to say that one of the great steps in evolution was the establishment of three great types of Protozoon. (*a*) Some were very active, the Infusorians, like the slipper animalcule, the night-light (Noctiluca), which makes the seas phosphorescent at night, and the deadly trypanosome which causes Sleeping Sickness. (*b*) Others were very sluggish, the parasitic Sporozoa, like the malaria organism which the mosquito introduces into man's body. (*c*) Others were neither very active nor very passive, the Rhizopods, with out-flowing processes of living matter. This amœboid line of evolution has been very successful; it is represented by the Rhizopods, such as Amœbæ and the chalk-forming Foraminifera and the

THE SABRE-TOOTHED TIGER *(James's Press)*

This animal, which was about the size of the European bear of to-day, roamed the world in the period of the Lower Pliocene. Its wide jaws and tusk-like upper teeth were specially adapted to preying on thick-skinned and short-necked creatures. Like the mammoth and the cave bear, the sabre-toothed tiger disappeared during the long period of sifting and changing known as the Pleistocene period.

organisation, which work against the inevitable processes of senescence, but sooner or later the victory is with ageing Another deep reason for natural death is to be found in the physiological expensiveness of reproduction, for many animals, from worms to eels, illustrate natural death as the nemesis of starting new lives Now it is a very striking fact that to a large degree the simplest animals, or Protozoa, are exempt from natural death They are so relatively simple that they can continually recuperate by rest and repair, they do not accumulate any bad debts Moreover, their modes of multiplying, by dividing into two or many units, are very inexpensive physiologically It seems that in some measure this bodily immortality of the Protozoa is shared by some simple many celled animals like the freshwater Hydra and Planarian worms Here is an interesting chapter in evolution, the evolution of means of evading or staving off natural death Thus there is the well known case of the Palolo worm of the coral reefs, where the body breaks up in liberating the germ cells but the head end remains fixed in a crevice of the coral and buds out a new body at leisure

[Photo Mondale

THE SEA ANEMONE LIVES LONG

The Sea anemone is an illustration of the evolution of the ways of avoiding death Simple one celled organisms like the amœba are immortal in the sense that they reproduce themselves by dividing into two or more individuals composed of the same parent—a method which is physiologically inexpensive More complex organisms are either devoured by others attacked by parasites or sooner or later according to their powers of adaptation they die naturally The passive resistance of the Sea anemone is a factor in its constitution which enables it to live and thrive in the zone of crashing breakers

Along with the evolution of the ways of avoiding death should be considered also the gradual establishment of the length of life best suited to the welfare of the species, and the punctuation of the life history to suit various conditions

§ 7

Great Acquisitions

In animals like sea anemones and jellyfishes the general symmetry of the body is radial, that is to say, there is no right or left, and the body might be halved along many planes It is a kind of symmetry well suited for sedentary or for drifting life But worms began the

profitable habit of moving with one end of the body *always in front*, and from worms to man the great majority of animals have bilateral symmetry They have a right and a left side, and there is only one cut that halves the body This kind of symmetry is suited for a more strenuous life than radial animals show, it is suited for pursuing food, for avoiding enemies, for chasing mates And *with the establishment of bilateral symmetry must be associated the establishment of head brains*, the beginning of which is to be found in some simple worm types

Among the other great acquisitions gradually evolved we may notice a well developed head with sense organs, the establishment of large internal surfaces such as the digestive and absorptive wall of the food canal, the origin of quickly contracting striped muscle and of muscular appendages the formation of blood as a distributing medium throughout the body from which all the parts take what they need and to which they also contribute

Another very important acquisition, almost confined (so far as is known) to backboned animals, was the evolution of what are called *glands of internal secretion*, such as the thyroid and the supra renal These manufacture subtle chemical substances which are distributed by the blood throughout the body, and have a manifold influence in regulating and harmonising the vital processes Some of these chemical messengers are called hormones, which stimulate organs and tissues to greater activity, others are called chalones, which put on a brake Some regulate growth and others rapidly alter the pressure and composition of the blood Some of them call into active development certain parts of the body which have been, as it were, waiting for an appropriate trigger pulling Thus at the proper time the milk glands of a mammalian mother are awakened from their dormancy

In the procession of life through the ages, covering about one thousand million years there has been a gradual emergence of higher and higher forms of life in the course of the successive ages Here it will be useful to consider the evolution of animal behaviour

(*To be continued on page* 409)

BOOK III—(*Continued from page 324*)

THE DEVELOPMENT OF RELIGIOUS THOUGHT AND MODERN DISCOVERY

CHAPTER III

THE RISE OF CHRISTIANITY—(*Continued*)

§ 1

ASSIMILATION OF GREEK IDEAS

WE may pass on now to another point to be noted in the general development of Christianity when it was extending its way into Asia Minor, Greece, and Rome It is a keenly debated question how far, and in what measure, Christianity assimilated ideas drawn from Greek philosophy, we shall deal with the influence of Greek philosophy in a moment Meanwhile, Christianity also appropriated to itself some of the rites and ceremonies of existing pagan mystery-religions that dated from a much earlier period, the fact of such borrowings and accretions has to be acknowledged Since we have already seen in a previous chapter what the nature and characteristics of the Eleusinian Mysteries and the Orphic Mysteries were, we need not discuss them further

[Photo Elliott and Fry

SIR GILBERT MURRAY

Professor of Greek at Oxford University and one of our greatest authorities on Greek literature He has written many notable books in particular we have drawn upon his *Four Stages of Greek Religion* for exposition in the present work and especially his views on the Greek mystery religions

It was into a world permeated by mystery religions that Christianity was introduced Dr Bevan writes as follows

In the Christian churches as in many of the mystery associations, men met in fellowship without respect to their race or social standing—Greek, barbarian, bond, free Again in both these mystery associations which worshipped Dionysos-Zagreus, Attis, Osiris, Adonis or Persephone and in the Christian Church worship was directed to a Divine Being who had undergone death and had risen again In both the virtue of the Divine Being's resurrection was believed to be communicated to the members of the society, so that they too claimed to have acquired an immortal life, which could not be impaired by bodily death In both the union of the society was expressed in communal meals, in the partaking together of food and drink, and in both certain acts of eating and drinking were held to have religious value Nor would it be just to deny to many of those

who joined some mystery-cult a genuine religious craving *

There is no suggestion here that the Christian Church was tolerant, as these pagan mystery-religions were tolerant of one another. The different pagan cults lived alongside each other and had no quarrel one with another. It is more than probable that "if the Christian Church had been *content to form one of this happy* family, to compromise with the pagan religions, with Emperor-worship and all the rest, it would probably have escaped persecution. It would also have perished, as all the rest have perished."

§ 2

Mithraism

In giving some account of the Greek mystery-religions in a previous chapter we omitted Mithraism. It comes *in more conveniently* here.

Among the pagan religions of the early centuries the most wide spread was Mithraism. The following summary represents what has been written by various scholars. There were worshippers of Mithras in extreme antiquity; its *ancient* home was among the primitive Aryans; Mithras was worshipped as a deity of light and truth warring against the power of darkness. "*Of old (says Sir Gilbert Murray)* Mithras had been a high God, but now he had lost in rank and gained in vitality. He was a hero, a redeemer, a mediator between man and God, a champion ever armed and vigilant in the eternal war of Ormuzd against Ahriman, light against evil and darkness." Legends of Mithras are his *birth from a rock and his adoration by shepherds*, and his final ascension to the heavens where he remained to protect the *faithful*. *Mithras appears* to have lived an incarnate life on earth; the ritual of Mithraism, it would seem, centred in the death of the sacred bull by Mithras rather than that of Mithras himself; the bull, created by *Ormuzd*, was *sacrificed* by order of the Sun and new life sprang from his blood. "Therefore, Mithras was the creator of life by virtue of this sacrificial act, and, like Osiris, he became the guide and protector of souls in quest of a blessed immortality." * Tarsus, the home of St Paul, was one of the great centres of Mithraic worship.

Mithraism Wide-spread

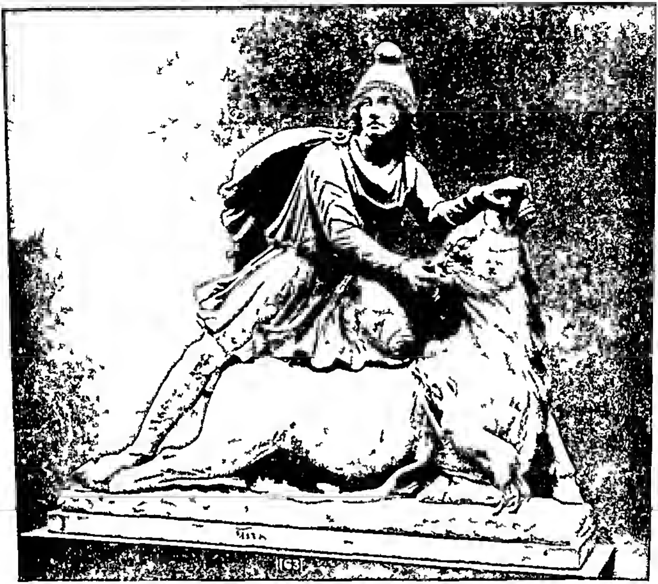
Mithraism had spread from Persia to the West, and even as far as Britain. There were many parallels to Christianity in Mithraic belief and ceremonies, and some of its secret rites and mysteries had close resemblance to those of Christianity. But it would be wrong to push these resemblances too far. Yet, as Sir Gilbert Murray says (and here he is among many authorities), "the similarities between Mithraism and Christianity are striking, and may be taken as signs of the spiritual and psychological needs of the time. Mithraism arose in the East, among the poor, among captives and slaves. *It* put its hopes in a *Redeemer*, a *Mediator*, who performed some mystical sacrifice. It held a Communion *Service of* bread and water. It rested on the personal *Pistis* (Faith, or faithfulness) of the *convert* to his *Redeemer*. *It had* so much acceptance that it was able to impose on the Christian world its own Sun day in place of the *Sabbath*; its Sun's birthday, 25th December, as the birthday of Jesus; its Magi and its Shepherds hailing the divine star, and *various of its Eastern celebrations*. On the *other hand, its Redeemer*, Mithras, makes hardly any pretence to have had an earthly history. It is all myth and allegory; elaborate ritual, sacraments, and mystic names, with *all* its varied paraphrasing *that is necessary* for bringing primitive superstitions up to the level which civilised man will tolerate." †

In a few cases, chiefly of ritual, Mithraic usages passed into the practice of the Christian Church. Sixty chapels to Mithras are *known to have* existed in Rome. Rome, says Gilbert Murray, saw in the second century the usefulness of Mithraism, and the Emperor Commodus was initiated; the philosopher-emperor Marcus *Aurelius* installed *Mithras on the Vatican, where* St Peter's now stands. It is not easy to under-

* *Christianity in the Light of Modern Knowledge* (Blackie & Son, Ltd.)

* E. O. James's *Origins of Sacrifice*

† *Christianity in the Light of Modern Knowledge* (Blackie & Son, Ltd.)



[Mansell

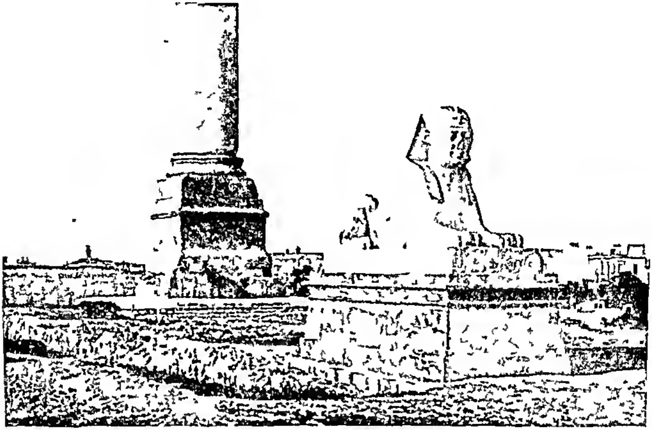
MITHRAS

Among the pagan rel g ons of the early centuries of the Christian era Mithra sm as the most w despread The s milarit es between M thra sm and Chr stian ty are striking and are expla ned in the text Legends of M thras are h s birth from a rock and his adorat on by shepherds and also a final ascens on to the other world The ritual of Mithraism it would seem centred in the death of the sacred bull by the hand of M thras rather than that of M thras himself Therefore says E O James Mithras was the creator of new l fe by virtue of this sacr fic al act and l ke Os r s he became the gu de and protector of souls in quest of blessed mmortal ty M thras s a legendary figure and the roots of th s pagan rel g on l e far back in ant qu ty

stand how this lofty minded emperor of Chris tian l ke graces and author of the *Meditations* should have consented to the persecution of Christ anity Yet he did He clung to the faith of his ancestors and has been called the flower of the Stoic philosophy A century after Marcus Aureli is the co emperors Licinius and Galerius dedicated a sanctuary on the Danube to Mithras the protector of their empire At its best Mithraism was a fine and notwithstanding its barbaric element manly rel gion spurring men to action guiding them by its d sc pline and teaching them to live honourably cleanly and even hol ly It was essentially the rel gion of the Roman army

Mithraism Decay

De Burgh in his *The Legacy of the Ancient World* writes The patronage of the third century emperors who valuing its influence on



[E N A

A RELIC OF ANCIENT ALEXANDRIA

The ancient city of Alexandria in Egypt was one of the chief centres of intellectual activity within the Roman Empire about the third century It was the headquarters of Hellenistic scholarship and represented an important point of contact between the philosophical doctrines of Greek and Jew It was 'a great factory and exchange of religious ideas' The illustration shows a sphinx recently unearthed at the base of Pompey s Pillar

magic pass into sacramental religion There is no line of demarcation, either in early religion or in Christianity itself Myth and cultus are the middle forms through which the worshipper hopes to close the cleft between sense and spirit, between the seen and the unseen, between time and eternity They are bridges, and all we ask of a bridge is that it shall reach from one bank to the other, and bear our weight The heavy handed dogmatist who turns them into flat historical recitals, and the vulgar rationalist who explains them by the duplicity of the first knave and the simplicity of the first fool, alike mistake their character and their function, which is sacramental' *

* *Things New and Old* (Longmans)

§ 3

The Influence of Greek Philosophy

We have now to consider another aspect of the rise of Christianity This time it is the theological—philosophical aspect What does Christianity owe to 'Greek philosophy? Dr Inge, in a striking essay contributed to R W Livingstone's *The Legacy of Greece*, remarks "Without what we call our debt to Greece we should have neither our religion nor our philosophy nor our science nor our literature" We are concerned here only with religion and philosophy, and that in itself is so large a subject we can only touch on the main features We cannot hope to survey the immense literature devoted to the subject of 'what we owe to Greece' In dealing with Pauline theology we emphasised that the cardinal and fundamental

signify the active force inherent in physical nature, as a whole and in its different parts We may almost think of it as Bergson s *élan vital*

In the Alexandrian philosophy, as represented by Philo the Logos is given a theological application as one writer says it assumes a leading place and shapes a new career for itself It is Plato s idea of the Good regarded as creatively active Hence instead of being merely immanent in the Cosmos it has an independent existence In Philo the Logos is not a personal being How Philo applied it to Judaism would take too long to go into here sufficient to say that he used the term Logos as signifying mystically, a mediator between the Infinite Eternal God and the finite transitory world and he saw 'a symbolical hidden meaning in the institution and ceremonial of the Law and even maintained that the meaning was the only valid meaning ' The Logos becomes a hypostasis that is an intermediate being or individual 'substance,' an independent spiritual entity that takes the place of God but proceeds from God figuratively a second God or an aspect of the divine activity

[Pl o o Ander on

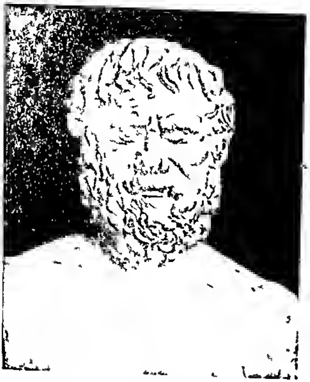
THE DISPUTE BETWEEN PETER AND PAUL

(After the pa nt ng by Gu do Ren)

St Paul imported nto the or ginal Gospel some theolog cal deas w h ch were strange to the Apostles and St Peter was not alw ays able to understand Paul s theological ph losophy The two men are shown in the illustrat on disputing

Now when we pass on to the Christology of the second and th rd century the Logos has become more defined The dominant conception of the Logos in St John s Gospel and the Epistle to the Hebrews *is now identified with Christ*

The philosophers who had originally given currency to the idea of the Logos had been engaged with the problem of metaphysically bridging the gulf between the eternal changeless God and an imperfect transitory world they regarded the Logos practically as a second God St John s identification of Christ with the Logos may be compared with Paul s taunt to the Athenians The God whom you ignorantly worship , St John says the Logos which you call a single word principle we say is that which was made flesh in the person of Jesus The abstract Logos of Philo has become



ZENO [Photo Anderson

342–270 B C

He was the founder of the Stoic philosophy to which many early Christian thinkers were attracted by its moral elevation and idealism

in Christology, fully personified or identified with Christ and is made to testify his divine nature Thus, then, in brief was the Christian doctrine of the Logos developed, and from it evolved many implications which resulted in a welter of Christological controversies

§ 4

Other Greek Influences

THUS we see that we must go far back in time if we are to trace the influences that entered into the making of Christian theology There were other influences besides Platonic and Aristotelian philosophy, there was also, for example, the religion, or philosophy, of the Stoics

Stoicism exercised a great influence in its own age and in later ages, and we might, perhaps, add in the modern world It left its mark on neo-Platonism Its founder was the philosopher Zeno (342–270 B C) The word Stoic lives in our language, meaning one who is indifferent to pleasure or pain Says Professor De Burgh, "Christian thinkers were attracted by its moral elevation and uncompromising idealism. In modern times, it stirred the admiration of such different philosophers as Descartes, Bishop Butler, and Immanuel Kant"

Its secret lay "in its appeal to man's power of will, and its resolute assertion both of human freedom and of divine providence The Stoic taught that, impotent as man seemed to be in the face of hostile circumstances, of slavery, torture, disease, and death, in reality he was absolute master of his will, and that on this mastery of will alone depended all the value and good of life . His reason gladly goes forth to meet the kindred reason of the world Thus by strength of inward self-determination, he conquers passion and wins tranquillity of soul Hence the Stoic precepts, Follow nature, Follow reason, Follow virtue, are merely different ways of saying the same thing The Stoic said also, Follow God, for, despite the somewhat crude materialism of his physical theories, he held that the law which governs the course of nature was

SENECA THE YOUNGER [Photo Rischgitz

4 B C–A D 65

The famous Stoic philosopher and tutor of Nero who was astounded at the hardships borne by Christians

ATHANASIUS

He upheld the doctrine of the Trinity which was bitterly opposed by the Arians. He fought strenuously all his life for his belief and was several times banished. Gibbon the historian praises his calm courage and the ascendancy of his genius.

no blind mechanism, but the rational working out of a divine purpose which was essentially good. In its thorough-going teleology, Stoicism fell into line with the traditions of Plato and Aristotle." * Its message is addressed to the individual.

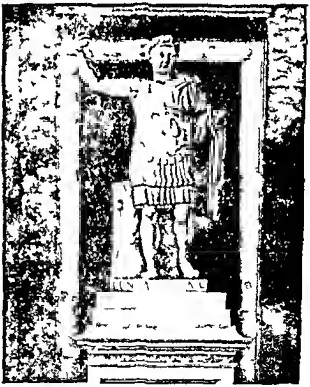
The school of the Gnostics was another influence; there were Gnostic sects before Christianity, but in the first centuries the Gnostics were centred at Alexandria; and as we shall see in a moment, they were regarded as a body of Christian heretics.

§ 5

CHRISTIANITY was by no means then the only creed competing for the dominion of the mind of the age. A most diverse assortment of speculative ideas was being thrown into the cosmopolitan melting pot of the Empire, and the interchange between Christianity and its rivals was constant and intimate. Hence the second century is a time of seething intellectual unrest within the Church, with constant dispute as to what was native to the faith and what was an alien corruption. But before we come to the time when doctrines began to be crystallised in settled formulas and dogmas a little more remains to be said.

The Gnostics

Principal among the elements that at the time claimed to be Christian, but were ultimately proscribed as "heresy," was the group of doctrines commonly called Gnosticism. The word *Gnosis* means "knowledge" or "understanding," but for the majority of the schools of Gnosticism the word was understood in the sense of "revelation." Their "knowledge" was not based on rational or scientific grounds but on a mysterious knowledge that comes by "revelation." The Gnostic religion, like other mystical religions, had its rites and formulas and symbols, acts of initiation, mysteries and sacraments.



[Photo Alinari

CONSTANTINE

A.D. 306-337

He was the first of the Roman Emperors to accept Christianity and published the Edict of Milan (311 A.D.) which granted tolerance to all Christians and placed Christianity on the same footing as the other religions in the Roman Empire.

* *The Legacy of the Ancient World*

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Many of the essential conceptions of the Gnostic philosophy were in existence before the rise of Christianity There are many schools of Gnostic thought, what was common to them all was the attempt to reconcile the infinite goodness and purely spiritual character of God with the existence of the imperfect material world They did so by denying the identity of the supreme ruler of the universe with the creator of man and matter The direct creations of the supreme God were a succession of spirits who are generally given the names of abstract ideas—Silence, the Abyss, Will, Wisdom, Truth, and so on From one such spirit or Æon others would be generated, until after many generations there comes into being a power called the Demiurge, who is so far removed from God that he is unaware of his existence, and deems himself to be almighty *

This Demiurge is the creator of the world we know, and it is because of the impurities introduced into his nature by his complicated Æonic pedigree that the world he creates contains evil Yet, ill as he has done his work, his creation contains elements of the truly divine, which are, so to speak, imprisoned in matter This spark of divinity the high God desires to rescue, and sends the most perfect of all the Æons, the Christ, to rescue it This is the meaning of the incarnation As to the process by which it came about the Gnostics differed among themselves, but they all advanced ideas in contradiction to what ultimately became accepted as orthodox Christian doctrine They generally spoke of some form of union between the Æon Christ and the man Jesus, but one or the other was generally made the sole reality, either the Saviour was represented as a man on whom divinity descended as a temporary gift, leaving him before his death on the cross, or else his nature was purely divine, and his humanity was a mere illusion Either theory was in conflict with the essence of Christianity, which clung in spite of all philosophical difficulties to the faith that the Master was both true man and true God

§ 6

More Contending Philosophies

We need not prolong this brief summary of events, of contending philosophies and religious strivings They were all characteristic of the religious life of a period when decadent paganistic beliefs of antiquity were passing, and thinking minds were straining after higher conceptions of the mystery of their being and man's relation to an unseen world, and the destiny of the soul after death Readers who are interested in these philosophies must go to the works of philosophical writers, and readers who wish details of the prolonged and bitter theological controversies that came to a head at the Council of Nicea, of which the Nicene Creed was the outcome (A D 325), or the no less strenuous controversies that raged round the formulation of the Athanasian Creed must go to the voluminous works of theological writers They will read of opposing factions, of violent actions, and long fought out battles, such as that illustrated in the case of a learned presbyter like Arius being excommunicated, restored, and excommunicated again He was the leader of the Arian party and the dispute centred round the doctrine of the Trinity (originally a purely philosophical conception)

The Arians taught that Christ was less than God The Gospel declared that Christ was both God and man, believers were baptised in the name of Father, Son, and Holy Spirit How was this to be conceived? "In the first place (*a*) in what relation did Christ, the Son, stand to the Father? Is the Godhead that was manifested in human form identical with the creator of the universe? On the one hand, unless there is a real unity, either Christ is not divine, or two gods must be affirmed, at the cost of a relapse into pagan polytheism There arose (*b*) the second aspect of the difficulty. How were the divine and human natures in Christ united in a single personality? Did God enter into a real union with human nature, thus raising that

* Gnosticism is a permanent tendency in human thought The following opening lines of a poem by Mr Humbert Wolfe, published within the last three years are markedly gnostic

> Creator of the spirit, self erected
> Since all creation is only thought ungodded
> By gradual matter, slowly separated
> From beauty that is for ever disembodied . .

[Bruckmann

THE APOSTLE PAUL

By Rembrandt

nature to the place of the divine? Otherwise redemption is chimerical and the hope of the Christian vain"

The Sabellians were accused of holding the theory of three equal Gods, but they "blurred" the distinction of Father, Son, and Spirit into one of attributes, or aspects of one God The Trinitarians, of whom Athanasius was the great leader, taught that the Father, Son, and the Holy Ghost were not three gods but one God The struggle between the Arian party and Athanasius was bitter and prolonged Even Gibbon could not forbear paying tribute to "the immortal name of Athanasius", his "calm courage" and "the ascendency of his genius" His life and character were irreproachable, and as another historian says, 'he stood firm as a rock amid the tempests that engulfed the world Five times he was driven from his episcopal throne, once for as long as six years, condemned by successive councils and by the imperial Government, he fought single handed—*Athanasius contra mundum*—for half a century against the combined ecclesiastical and political forces of the empire" In A D 335 when the Arian party was in the ascendant and charges were brought against him the Emperor Constantine, with whose will he had refused to comply sentenced him to banishment, but three years later he was recalled and restored to his primacy at Alexandria Some years later he had to flee from his persecutors and made his escape into the Egyptian desert And so it went on, until his final restoration to his see, in which he continued till his death in A D 373 The Trinitarian doctrine for which he fought triumphed The final expression of it is contained in the Creed that bears his name It did not appear as the Athanasian Creed" until about four hundred years after Athanasius had passed away * The dogma of the Trinity in its philosophical bearings and in the contentions of these early Christian thinkers comes into closest contact with the problems of Greek philosophy.

* The concept round which the controversy gathered of *ousia* (essence) and *hypostasis* (individual substance) had long been familiar to Greek philosophy *Ousia* goes back to Plato and, especially, Aristotle, it means both individual substance and the essential nature of a thing The two terms (*ousia* and *hypostasis*) were used as equivalents as late as the fourth century, e g, Athanasius' (De Burgh *Legacy of the Ancient World*)

The True Perspective

We have dwelt on these subjects here in order to illustrate the intellectual influence Hellenism had in shaping Christian thought, and the theological side of the Christian faith in the early centuries The student pursuing the history of dogma sees creeds growing in complexity, in elaborate analysis, and inventiveness of doctrinal statement, he will be involved in almost a life time of study to understand the history and the nature of interminable theological theories The point of our referring to all this is simply to make clear the historical fact that all this happened, inevitably, in the development of institutional Christianity But we must keep a true perspective "It is easy for the sceptic to mock at these disputes But even if we think that these attempts to say exactly how God was related to himself were presumptuous and intellectually monstrous, nevertheless we are bound to recognise that beneath these preposterous refinements of impossible dogmas there lay often a real passion for truth—even if it was truth ill conceived

"Both sides produced genuine martyrs And the zeal of these controversies, though it is a base and often malicious zeal, did at any rate make the Christian sects very energetically propagandist and educational Moreover, because the history of the Christian body in the fourth and fifth centuries is largely a record of these unhappy disputes, that must not blind us to the fact that the spirit of Jesus did live and ennoble many lives among the Christians The text of the gospels, though it was probably tampered with during this period, was not destroyed, and Jesus of Nazareth, in his own manifest inimitable greatness, still taught through that text Nor did these unhappy quarrels prevent Christianity from maintaining a united front against gladiatorial shows and against slavery, and against the degrading worship of idols and of the god Cæsar" *

* *Outline of History*, H G Wells

§ 7

In the Third Century

IN the third century we have to note the great influence of Plotinus, whose philosophy even to day has such attraction for scholars like Dean Inge Plotinus, "the last great thinker of the ancient world," developed the mystical element in Plato's thought, and made it the centre of a system "Plotinus brought together elements from Aristotle and the Stoics as well as from Plato, and fused them in the light of a mystical experience In Plotinus' view the supreme Being is the Absolute One of whom we can make no affirmations or denials He is ineffable —beyond the duality of thought" Dr Inge says, "No other guide even approaches Plotinus in power and insight and profound spiritual penetration I have steeped myself in his writings, and I have tried not only to understand them, as one might try to understand any other intellectual system, but to take him, as he assuredly wished his readers to take him, as a guide to right living and right thinking We are in the presence of one of the great epoch making personalities, whose part in the history of the world is not yet played out" We must therefore say a little more about him

Plotinus, and Neo Platonism

Plotinus (A D 205–270) studied philosophy at Alexandria, but for the last twenty six years of his life he lived in Rome, where his lectures attracted crowds of eager youths, as well as educated men and women of the highest circles The century of Plotinus saw the rise of Neo Platonism, which was something more than a revival of older doctrines, it was a union of old and new Plotinus was the first and greatest of its masters Neo-Platonism has been called "the final utterance of the speculative genius of Greece" The supreme aim of Plotinus was to realise philosophy as religion, his philosophy was essentially religious For him, like Plato, the real world is the world of the unseen, the eternal "For him 'the good life' itself is its own reward, and we must look for no other, he disdains the threats and promise of ecclesiasticism" Plotinus "attempts to unite and reconcile what was best in all Greek philosophy, but he claims to have found the way of deliverance and salvation for the soul of man, in whatever circumstances he may be placed" His philosophy, as a spiritual interpretation of the universe, had an immense influence on Christian thought, although he never mentions Christianity As Dr. Inge says, "Neo-Platonism is a part of the vital structure of Christian theology, and it would be impossible to tear them apart"

His Mysticism

The mystic element in the teaching of Plotinus is a mysticism "built on a basis of rationalism", *he does not shrink from saying that there is that in us which makes contact with the One possible We must not confuse this intellectual mysticism with the type of mysticism which is merely 'a susceptibility to passionate or rapturous emotion'* For Plotinus, as for Plato, mysticism rests upon metaphysics

Mysticism involves a philosophy and at *bottom is a philosophy Although it never leaves* the pathway of individual and concrete experience, it values that experience precisely as being not merely subjective, not merely individual, but as a revelation of universal and eternal truth Mysticism is a spiritual philosophy which demands the concurrent activity of thought, will, and feeling There is no special organ for the reception of Divine or spiritual truth, which is simply the knowledge of the world as it really is Some are better endowed with spiritual gifts than others, and are called to ascend higher heights, *but the power which leads us up the pathway to* reality and blessedness is, as Plotinus says, one which all possess though few use it *

Mysticism "is the whole personality, unified and harmonized under the leadership of what the Stoics called the ruling faculty, that enters the holy of holies" The intellect here is not an intruder nor an obstacle in the spiritual life The deep spiritual religion of Plotinus rests partly on philosophic thought and partly on intimate personal experience 'It stands free of any historical events in past or future For this reason Plotinus has a message for us to day' God, supreme Reality (not the

* *The Philosophy of Plotinus* By Dr Inge (Long ——)

[Photo Anderson

THE MADONNA OF THE MAGNIFICAT

By Botticelli

Christian art did not develop until some centuries after the establishment of Christianity as a State Religion. Sir William Orpen says "We cannot trace the beginning and development of Christian art without payin tribute to the miraculous genius of Greece. Four centuries before Christ the Greeks had brought sculptur to a point of *perfection and physical beauty which has never since been surpassed.* *Under the Roman Empir* the traditions of the Greeks were kept alive, but with the decline and fall of Rome the fine arts were temporaril submerged. During the dark ages painting as a secular art almost entirely disappeared, and in the early day of the Church the Fathers gave little encouragement to art. 'Cursed be all who paint pictures' is a sentimen not infrequently found in their writings."

After a long period of frigid conventionality Christian art entered upon a naturalistic phase. Men of geniu painted religious subjects as they felt them.

Of all the fourteenth-century Italian painters whose names are famous in history, none surpassed Alessandr Botticelli in the creation of works of sheer beauty. 'The Madonna of the Magnificat' is generally regarde as the supreme example among his many paintings of the Madonna, both for its decorative charm and its intens spirituality of expression.

Deity of personal theism), is knowable, but, in the words of Plato, he is *visible to the mind alone*

We shall not attempt to expound Neo Platonism in detail, nor the philosophy of Plotinus To the novice these metaphysical conceptions may seem as strange and abstruse as modern Relativity theory, they are outside a "common sense" way of thinking In both cases it is only when the mind has familiarised itself with the ideas expressed that they begin to get clear and take shape, and become something that we can, in a sense, visualise It is not possible, in the space at our disposal even to begin to discuss the views of Plotinus on the nature of reality and the "Trinity of Divine Principles' — these are the Absolute, Spirit, and Soul, and the tripartite division of man into Spirit, Soul, and Body The universe from its highest principle, the One or the Good, to its lowest presents a continuous scale of being, "a graduated hierarchy of existence and value, in every grade of which the soul finds affinities' There is a constant transmission of powers, through several agencies, from the Absolute ('beyond existence) to the created "The One is the beginning and the *end the Alpha* and the Omega, of the universe," the creative source is also the final goal Plotinus' theory of individual souls relates itself to the Universal Soul "which is not only the creator of the world, but the providence which watches over it"

[*Photo Anderson*

THE ASSUMPTION OF THE VIRGIN

By Titian

Titian s dramatic masterpiece rich and powerful both in portraiture and in allegorical decoration is here seen applied with equal genius and deep feeling to the rendering of a religious subject This picture was thought by Titian s contemporaries to be the best modern painting

[Photo Braun

THE DESCENT FROM THE CROSS

By Rubens

Though temperamentally unfitted to be a religious painter Rubens by his splendid colour, flowing design and naturalness of presentation gives so fine a rendering of this awesome subject that it is counted to be his supreme achievement

THE TRANSFIGURATION [Pho o Anderson

By Raphael

Th s p cture at the Vatican Raphael s last great v ork sho vs the transfiguration of Christ between Moses and El jah I rostrate on the ground are Peter James and John n ar ed att tudes In the foreground an exc ted group gathers round the boy possessed of de ils

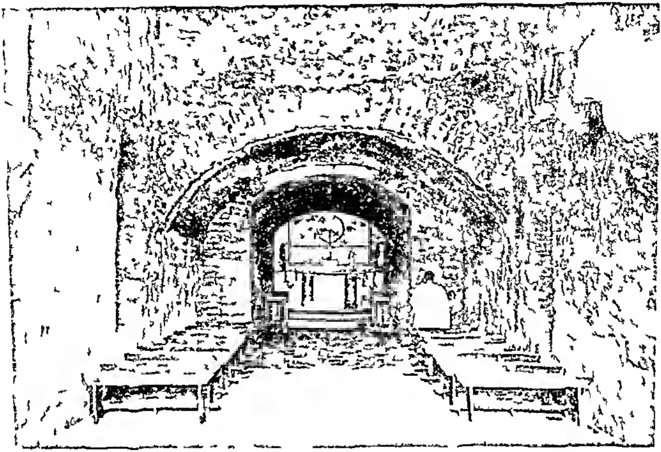
Neo Platonism in Christian Thought

But all this is saying very little, Plotinus is not easy to follow, and to "*explain*" *him* would mean far more space than is available here

We are merely trying to suggest in what way Neo-Platonism influenced the character of the new religion in its doctrinal development, which began with Paul Plotinus' philosophy is spiritual As Dr Inge remarks, Plotinus would have admired the prologue of the Fourth Gospel, which might never have been written but for the influence of Neo-Platonism, which culminated in Plotinus "In the beginning was the Word (Logos) and the Word was with God and the Word was God The same was in the beginning with God All things were made by him, and without him was not anything made that was made In him was life and the life was the light of man And the light shineth in darkness, and the darkness comprehended it nŏt" Neo-Platonism in effect was a sort of fusion of rival schools of Greek philosophy, and it is a great German scholar who says that "the pagan Plotinus has left a deeper mark upon Christian thought than any other single man" Christianity was vastly enriched by what it gradually absorbed of Neo Platonism

answer that question there must be an authority capable of deciding on controverted issues; and that authority the second century Christians found in the bishop of the diocese Clearly it was important that he should speak with a single voice, and so at this time the surviving "collegiate" constitutions disappeared in favour of the single monarchical bishop, who henceforth acquires a greatly enhanced power and prestige

But one local church and its bishop might differ from another, and the need for a further court of appeal was therefore felt Certain bishoprics, generally owing to some real or legendary connection with an apostolic founder, enjoyed special veneration, and the bishops of these came to be appealed to to arbitrate upon disputes between their episcopal brethren Such were the bishop of Antioch in Asia Minor, of Lyons in Gaul, of Carthage in Northern Africa, of Alexandria in Egypt The bishop of the imperial capital, Rome, claimed to represent the tradition of Peter, the prince of the apostles, as well as of Paul, the founder of theology, was very widely regarded as the repository of a specially pure doctrine, and he in the last resort was usually accepted as a final and decisive authority



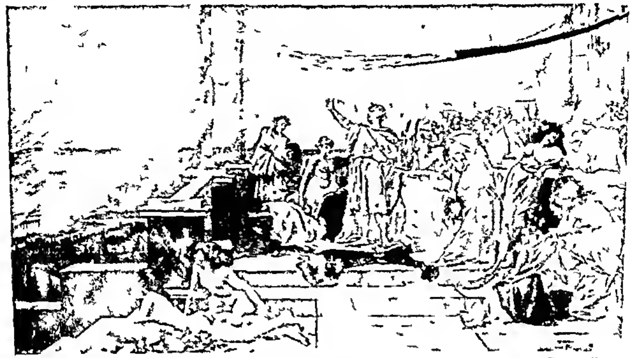
[E N.A

INTERIOR OF THE CHAPEL OF THE AMPHITHEATRE CARTHAGE

Carthage played an ausp c ous part in the early history of Christian ty The great persecution launched by the Emperor Decius had scattered the Christ ans of North Africa and many under threat of death had den ed the fa th In the Chapel of the Amphitheatre a cross was erected in A D 20 to commemorate the martyrdom of *those who rema ned fa thful* Carthage was the scene of many important Synods or conferences Cyprian the famous B shop of Carthage re adm tted lapsed Christ ans into the church on terms of confess on and penance thus establ sh ng a precedent of far reach ng significance

threatened to usurp from the bishops and clergy the real control of the churches owning allegiance to Carthage At the same time the controversy spread to Rome, where it became linked with a schismatic movement that set up a rival claimant Novatus against the bishop of Rome

After long controversy the dispute was settled *in favour of leniency*, largely by the influence of the illustrious Cyprian bishop of Carthage The decision was of fundamental importance for the future of Christianity Hitherto the dominant conception of the Church was that it was an assembly *of saints* *Baptism* remitted sins, however grave, committed in the unregenerate pagan state , but after that the Christian was expected to live a life of heroic virtue, and one grave lapse might be held to cast him out of the fold for ever On those terms Christianity could never become a world religion for men and women of common unheroic mould The decision at Carthage established a different principle For the future all sins might be forgiven , a man might offend again and again and still make his peace with the Church But to recover his status he must do penance, confessing his sins and performing what act of expiation his priest might impose upon him Penance took its place as a sacrament of the Church the condition of participation in the greater sacrament of the Eucharist , and the priest who presided over it acquired a vast extension of his spiritual authority The movement of the confessors of Carthage was the last effort of the laity to control the Church , henceforth sacerdotal sovereignty was absolute



[Photo Alinari

THE BURNING OF ROME A.D. 64
(After the painting by Pietro Aldi)

The early Christian communities were regarded by the Roman State as dangerous secret societies and tales of their imagined doings behind locked doors gave rise to general suspicion and distrust. Any disastrous happening in the city was attributed to the presence of Christians and popular opinion demanded that they should be made scapegoats. The Christians were wrongly blamed for the great fire of Rome. Yielding to the panic of the public, Nero consented to an organised persecution of those who held the new faith. It is thought that both Paul and Peter lost their lives during this period.

Fathers of the Church

Largely as a consequence of the conflict with Gnosticism and other heresies, but also as a by-product of the pastoral care exercised by some of the bishops, Christian literature was enriched during this period by the writings of a series of eminent leaders, who are known collectively as the Fathers of the Church. Sometimes writing in defence of Christianity against its traducers, sometimes in reply to the heterodox, they steadily worked out the implications of Christian teaching and filled in the outline of theology as it had been left by Paul.

The work began in the first century with the epistles of Clement of Rome. The great names of the second century include Polycarp, Bishop of Smyrna; Irenaeus, who wrote a *Refutation of False Knowledge*; Ignatius, Bishop of Antioch, author of one of the earliest treatises against heretics; Tertullian, the African opponent of the Montanists, a mighty controversialist, but one who presented Christianity in a singularly harsh and unlovely form; and Clement of Alexandria, the pioneer of a notable tradition.

In the third century the intervals of toleration were so long that it became possible to organise, in the catechetical school of Alexandria, what was practically a Christian university. Here its famous head, Origen (185–254), the most distinguished scholar and philosopher Christianity had yet produced, devoted his life to digesting the whole content of Christian thought into a complete and reasoned system of theology. Some of his vast and soaring speculations were subsequently repudiated by the Church; but when he died, broken by the torture of the rack in the Decian persecution, Christianity had come of age as an intellectual system, able to meet on equal terms the "pagan" philosophies

including Platonism, lately revived by Plotinus to make the last effort of Greek philosophy to explain the mystery of the world

Such, then, was the evolution of Christian theology begun by Paul, who borrowed so much from Greek philosophy, to Origen who finished it—up to the point we have reached

CHAPTER IV

CHRISTIANITY BECOMES THE STATE RELIGION

§ 1

WE now turn to the question of the progress of Christianity towards becoming the State religion (We have anticipated that somewhat in the foregoing pages) In spite of its illegality the new religion began to spread through the Empire with prodigious rapidity, indeed, so early as 112, Pliny, Governor of Bithynia, pleads the huge numbers of the Christians as a reason for the impossibility of enforcing the law Before the apostolic generation had passed from the scene Christianity had become the object of persecution At least two reasons for this can be discerned—a reason of State and a popular reason

A cardinal object of the policy of the Cæsars was to weld together all the races under their sway into a single imperial nationality and a single Græco Roman culture In doing so they sought to break up lesser loyalties and to dissolve societies smaller than the State, particularly secret societies Now the Christian communities were secret societies of a particularly obstinate kind, and the State hated secret societies The test of loyalty to the State was the formal participation in the State religion a conventional homage to the divinity of Cæsar himself To the ordinary

[Photo Rischgitz

BURIAL OF CHRISTIAN MARTYRS IN THE CATACOMBS
(After the painting by J E Lenepveu)

The persecution of the early Christians in Rome was largely political Any new relig on was regarded as a disloyalty to the Emperor and State Christians who refused to recant their faith were put to death in various ways Ultimately Christians pervaded all ranks of society and became a political force in themselves The Emperor Galerius who had been a rigorous persecutor of Christians published just before he died (A.D 311) an edict granting toleration to the adherents of the new religion

[Rischgitz

CONSTANTINE AT THE BATTLE OF MILVIAN BRIDGE

(After Raphael)

He was the first Roman Emperor to see that the accession of Christianity to official power was imminent. Legend has it that he saw a vision of a flaming cross in the sky at noon-day with the legend which translated is In this Conquer

polytheist or to the follower of a mystery cult an occasional purely formal offering to one more god was no great matter, but to the Christian monotheist it was a matter of conscience, and he was bound to refuse, thereby casting suspicion on his patriotism Add to this that the Christians conducted their rites in secret, and in daily life kept very much to themselves, not, like the ordinary mystics, mixing and intermarrying with their neighbours, and the government might be excused for suspecting them of seditious intent And here the reason of State links up with the popular reason, for a body of people who thus hold aloof from the life of their fellow citizens, as any modern Jew in eastern Europe could testify, quickly becomes suspected, on no evidence whatever, of the most horrifying enormities The tales told of the doings of the Christians behind locked doors were hideous in the extreme and in any time of popular panic or rage the Christians were the obvious scapegoats, of whom the Government were only too glad to avail themselves

Such a panic broke out as a consequence of the Great Fire of Rome in A D 64 The historian Tacitus tells us that so early as this there was a "great multitude" of Christians in the capital, and the people turned on them, not, it seems, as incendiaries, but as having called down the wrath of the gods at their enormities The Emperor Nero fell in with the popular mood, and began to put Christians to death wholesale by burning them alive in the Vatican gardens Tradition has it that the two chief apostles were both in Rome at this time, and that both were executed, Peter by crucifixion, Paul by beheading Certain it is that from now on, with the exception of the half legendary John on the Island of Patmos, we hear no more of the apostles

§ 2

FOR the next two centuries the development of Christian thought goes on against a background of persecution Under the Emperor Trajan (died A D 117) Christianity was proclaimed an illegal religion, and its profession made punishable with death

We must not, however, suppose that Christi were the victims of a continuous campai of extermination Practical-minded Rom governors were as a rule strongly averse fr making war upon idea so long as t Christians took care not to promote civil co motion by falling foul of their neighbours, th could generally expect to be left alone authority Most of the Emperors, too, favour a lenient application of the law, and so, ap from the activities of informers, prosecutions Christians were for the most part confined spasmodic "drives" initiated at times of publ excitement, when popular fanaticism had to given its head Then, indeed, the fate of th hapless Christians might be hapless indee torture would be applied to induce recantatio and where that failed the death penalty might b applied by a variety of methods, ranging fro the comparatively humane decapitation to th peculiar horror of being devoured by wild beas in the public amphitheatre

Persecution

In the main, then, the persecution of the earl Christians was due to the fact that their religio seemed incompatible with good citizenship, i prevented them acknowledging the usual obliga tion to the gods of the community, which reall meant no more, in effect, as Gilbert Murray put it, than a formal raising of the hat, as with us when "God Save the King" is played, it was taken as a disloyalty to the Emperor and the government, Christians, like the devotees of other religions, were expected "to pay honour to the *genius* of Rome and of Augustus, the religious symbol of the political unity of the empire, this tribute involved no renunciation of other divinities and no profession of religious faith; it was but a formal act of allegiance to Cæsar on the part of Cæsar's subjects That any one should boggle at it on religious grounds was incomprehensible to the Roman mind" But the Christians stood fast to the principle of the one faith, the driving power was a devotion to their Master which was all compelling

That faith was steadily gaining favour and influence It was becoming apparent that the

[Rischgitz

CONSTANTINE AT THE BATTLE OF MILVIAN BRIDGE

(After Raphael)

He was the first Roman Emperor to see that the accession of Christianity to official power was imminent. Legend has it that he saw a vision of a flaming cross in the sky at noon-day, with the legend which, translated, is "In this Conquer."

Christians had so far increased in numbers as to be bidding for an actual majority of the population in many parts of the Empire They pervaded all ranks of society, and neither the army nor the civil administration could do without them With the Goths threatening the frontiers and dynastic feuds constantly dividing the Empire, the Christians were a political force to be reckoned with by any claimant to the throne or other bidder for power This is the last phase of the pagan empire, he who would be Augustus must proclaim either a Christian or an anti Christian programme Some tolerated Christianity, the greatest of the third-century Emperors, Diocletian made a last despairing effort to suppress it He failed, and his failure showed how greatly the Church had strengthened its hold in the generation since Decius

Galerius (died A D 311) had been one of the most rigorous and cruel persecutors of the Christians, but, says Gibbon, "he at length became convinced that the most violent efforts of despotism are insufficient to extirpate a whole people, or to subdue their religious prejudices" Desirous of repairing the mischief that he occasioned he published an edict, just before he died granting toleration of the Christian religion In part it reads, "The edicts which we have published to enforce the worship of the gods having exposed many of the Christians to danger and distress many having suffered death and many more, who still pe in their impious folly, being left destitute of *any* public exercise of religion we are disposed to extend to those unhappy men the effects of our wonted clemency We permit them, therefore, freely to profess their private opinions and to assemble in their conventicles without fear or molestation provided always that they preserve a due respect to the established ws and government By another rescript we shall signify our intentions to the judges and magistrates and we hope that our indulgence will engage the Christians to offer up their prayers to the Deity whom they adore for our safety and prosperity, for their own, and for that of the republic" For those who had eyes to see, the accession of Christianity official power must have seemed imminent

The man who had eyes to see was Constantin who was one of several joint emperors warri among themselves for the division of the inher tance Legend says that he saw a vision of flaming cross in the sky at noonday, with th legend which translated is "In this Conquer" whatever actually happened he did undoubted decide to make a bold bid for a full alliance wi the Christians, he placed a Christian emble on his standards and marched on Rome great victory over his rival Maxentius he took a sign that his choice was right, and in th following year, making terms with the co emperor Licinius for a settlement of the whol Empire, he issued the Edict of Milan (A D 313) whereby Christianity became a lawful religio throughout the Roman world It was not ye made a State religion, nor was Constantine him self baptised, but the end of the warfare betwee the Cæsars and the Christians was reached Bishops became the Emperor's advisers, he himself claimed the right to preside over the deliberations of the universal Church Under his direction the first great assembly or council, of all the churches of the Roman world was held at Nicea, in north eastern Asia Minor in A D 325 This we have already referred to

A New Epoch Opened

totally new epoch opened for Christianity, with vastly wider horizons Ecclesiastical leaders were called on for the contribution of Christian thought to the problems of government in a threatened civilisation The profession of the faith became the passport to the favour of princes, with all the moral perils that that implies The time was in sight when to become a Christian, instead of being an act of heroic defiance, would be the line of least resistance "Woe unto you when all men speak well of you!" The Church was about to enter upon a testing time in conditions none of its members had ever known

(To be continued ...)

END OF VOLUME I